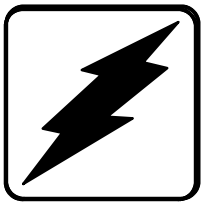
Service and Parts

Automatic Transfer Switches



Models:

MMS/MNS
TES/TLS
ZCS/ZCB

Electrical Controls:
E33+ Solid-State

ISO 9001
KOHLER GENERATORS
INTERNATIONALLY REGISTERED
U.S.A. Plant ISO Registered

KOHLER®
POWER SYSTEMS

TP-5670 9/94b

Table of Contents

Safety Precautions and Instructions

A transfer switch, like any other electromechanical device, can pose potential dangers to life and limb if improperly maintained or imprudently operated. The best way to prevent accidents is to be aware of the potential dangers and to always use good common sense. In the interest of safety, some general precautions relating to operating of a transfer switch follow. Below are some general precautions relating to the operation of a transfer switch. SAVE THESE INSTRUCTIONS.

DANGER

Danger indicates the presence of a hazard that *will* cause *severe* personal injury, death, or substantial property damage if the danger is ignored.

WARNING

Warning indicates the presence of a hazard that *can* cause *severe* personal injury, death, or substantial property damage if the warning is ignored.

CAUTION

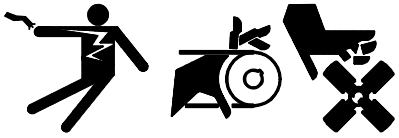
Caution indicates the presence of a hazard that *will* or *can* cause *minor* personal injury or property damage if the caution is ignored.

NOTE

Note communicates installation, operation, or maintenance information that is important but not hazard related.

Accidental Starting

⚠ WARNING



Accidental starting.
Can cause severe injury or death.

Disconnect battery cables before working on generator set (negative lead first and reconnect it last).

Accidental starting can cause severe injury or death. Turn generator set master switch to OFF position, disconnect power to battery charger, and remove battery cables (remove negative lead first and reconnect it last) to disable generator set before working on any equipment connected to generator set. The generator set can be started by automatic transfer switch or remote start/stop switch unless these precautions are followed.

Battery

⚠ WARNING

Sulfuric acid in batteries.
Can cause severe injury or death.

Use protective goggles and clothes. Battery acid can cause permanent damage to eyes, burn skin, and eat holes in clothing.

Explosion can cause severe injury or death. Battery gases can cause an explosion. Do not smoke or permit flame or spark to occur near a battery at any time, particularly when it is being charged. Avoid contacting terminals with tools, etc., to prevent burns and sparks that could cause an explosion. Remove wristwatch, rings, and any other jewelry before handling battery. Never connect negative (–) battery cable to positive (+) connection terminal of starter solenoid. Do not test battery condition by shorting terminals together. Sparks could ignite battery gases or fuel vapors. Ventilate any compartment containing batteries to prevent accumulation of explosive gases. To avoid sparks, do not disturb battery charger connections while battery is being changed. Always turn battery charger off before disconnecting battery connections. Remove negative lead first and reconnect it last when disconnecting battery.

Hazardous Voltage/ Electrical Shock

600 Volt and Above

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Do not open enclosure until all power sources are disconnected.

(600 Volt and above)

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Disconnect power sources before servicing. Barrier must be installed after adjustments, maintenance, or servicing.

(600 Volt and above)

Under 600 Volt

⚠ WARNING

Hazardous voltage.
Can cause severe injury or death.

Disconnect power sources before servicing. Barrier must be installed after adjustments, maintenance, or servicing.

(under 600 Volt)

⚠ WARNING

Hazardous voltage.
Can cause severe injury or death.

Do not open enclosure until all power sources are disconnected.

(under 600 Volt)

Hazardous voltage can cause severe injury or death. Short circuits can cause bodily injury and/or equipment damage**.** Do not contact electrical connections with tools or jewelry while adjustments are made. Remove wristwatch, rings, and jewelry that can cause short circuits.

Hazardous voltage can cause severe injury or death. Keep unauthorized persons away from the generator set and take precautions to prevent unqualified personnel from tampering with the transfer switch. Have the generator set and electrical circuits serviced only by qualified technicians. Wiring should be inspected at the recommended interval shown in the service schedule—replace leads that are frayed or in poor condition. Do not operate electrical when standing in water or on wet ground.

Hazardous voltage can cause severe injury or death. To prevent the possibility of electrical shock, disconnect harness plug before installing any accessories involving connection to transformer assembly primary terminals 76, 77, 78, and 79. Terminals are at line voltage!

Hazardous voltage can cause severe injury or death. To prevent the possibility of electrical shock, deenergize the normal power source to be connected to the transfer switch before making any line or auxiliary connections.

Hazardous voltage can cause severe injury or death. Disconnect inner panel harness at in-line connector. This will deenergize circuit board and logic circuitry, but allow transfer switch to continue to supply utility power to necessary lighting and equipment. Hazardous voltage will exist if any accessories mounted to inner panel are NOT wired through the inner panel harness and deenergized by in-line connector separation. Such accessories are at line voltage.

Notes

Charge only lead-acid or nickel-cadmium batteries with battery charger.

Charger Damage! Connect battery charger only to a battery with the same DC voltage as the battery charger output rating.

Hardware Damage! Transfer switch may use both American standard and metric hardware. Use the correct size tools to prevent rounding of bolt heads and nuts.

When replacing hardware, do not substitute with inferior grade hardware. Screws and nuts are available in different hardness ratings. American Standard hardware uses a series of markings and metric hardware uses a numeric system to indicate hardness. Check markings on bolt head and nuts for identification.

Introduction

This manual covers the operation, troubleshooting, repair, and service parts for the E33+ solid-state logic controller.

Read through this manual and carefully follow all procedures and safety precautions to ensure proper transfer switch operation and to avoid bodily injury. Keep this manual with the transfer switch for future reference.

Service requirements are minimal but are very important to the safe and reliable operation of the transfer switch; therefore, inspect associated parts often. It is recommended that an authorized service distributor perform required service to keep the switch in top condition.

All information found in this publication is based on data available at time of printing. The manufacturer reserves the right to make changes to this literature and the products represented at any time without notice and without incurring obligation.

List of Related Manuals

The logic controller covered in this manual is part of a family of related devices. Separate service and parts manuals are available for each group within the overall family. Be sure this manual is the correct manual for the automatic transfer switch.

A power conversion unit is included in each automatic transfer switch. There are three types of power conversion units and each type is covered in a separate service and parts manual. To be complete, the logic controller service and parts manual must be accompanied by a copy of the service and parts manual for the power conversion unit used in that automatic transfer switch. The power conversion service and parts manual contains all of the wiring diagrams and schematics for each of the logic controllers. Available power conversion units and the related manual numbers are as follows:

Models (Power Switching Device)	Service/ Parts Manual
MMS/MNS (molded case circuit breaker or switch 40 to 4000 amp)	TP-5666
TES/TLS (electrically and mechanically held contactors 40 to 400 amp)	TP-5667
ZCS/ZCB (contactor or bypass isolation switch 150 to 3000 amp)	TP-5668
MMT/MNT (molded case circuit breaker or switch 40 to 1250 amp)	TP-5973

Service Assistance

For service or information, consult the yellow pages of the telephone directory under the heading GENERATORS—ELECTRIC for the Authorized Kohler Service Distributor/Dealer.

KOHLER CO., Kohler, Wisconsin 53044
Phone 920-565-3381
Fax 920-459-1646 (North American Sales)
920-459-1614 (International Sales)
For Sales and Service in U.S.A. and Canada
Phone 1-800-544-2444

In communications regarding the automatic transfer switch, please include the PART and SERIAL numbers provided on the nameplate attached to the transfer switch. Enter the numbers in the spaces provided below. This information will enable the authorized Kohler service distributor/dealer to supply the correct part or information for your particular model.

Part No. _____

Serial No. _____

Notes

Section 1. Specifications

Purpose of Switch

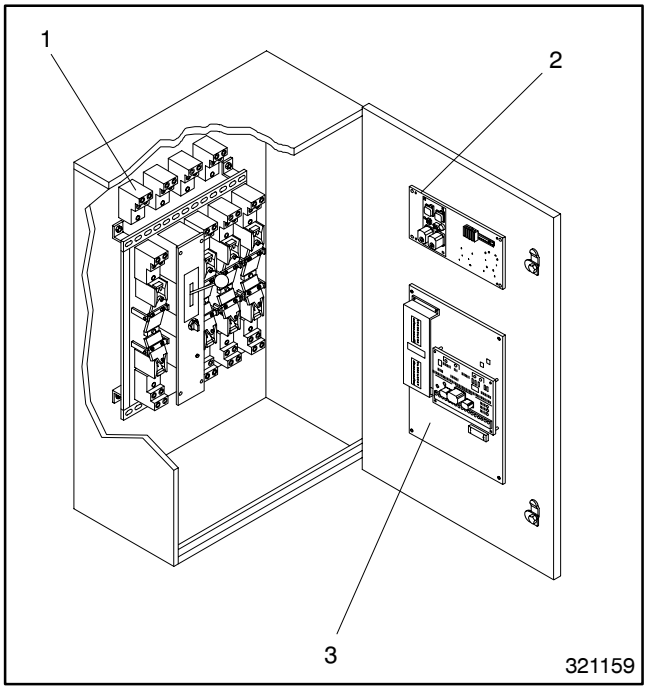
An Automatic Transfer Switch (ATS) is a device used for transferring critical electrical loads from a normal (preferred) source of electrical power to an emergency (standby) source. This transfer occurs automatically when the normal source voltage fails, or is substantially reduced, and the emergency sources voltage has reached an acceptable level.

Upon normal source failure, the automatic transfer switch controller signals the generator set(s) to start, and transfers to the emergency source. The automatic transfer switch controller continuously senses for an acceptable normal source and will retransfer the load to the normal source after it has been restored to an acceptable level. After retransfer of the load, the generator set start signal is removed and the generator set(s) are allowed to shut down.

Components of Switch

A typical automatic transfer switch includes the power switching device and the logic controller to perform power monitoring and transfer sequencing tasks. See Figure 1-1. An interface board is also included to match the standard controller inputs/outputs to the levels required by a specific switching device.

The three functional units that make up the automatic transfer switch are mounted in an enclosure with a hinged front door. The controller mounts on the back of the front door so its controls and indicators are available to an operator. A signal cable, with in-line connectors to facilitate component replacement and door removal, connects the controller to the interface board and the switching devices.



1. Switching Device
2. Interface Panel
3. Logic Controller

Figure 1-1. Transfer Switch Components

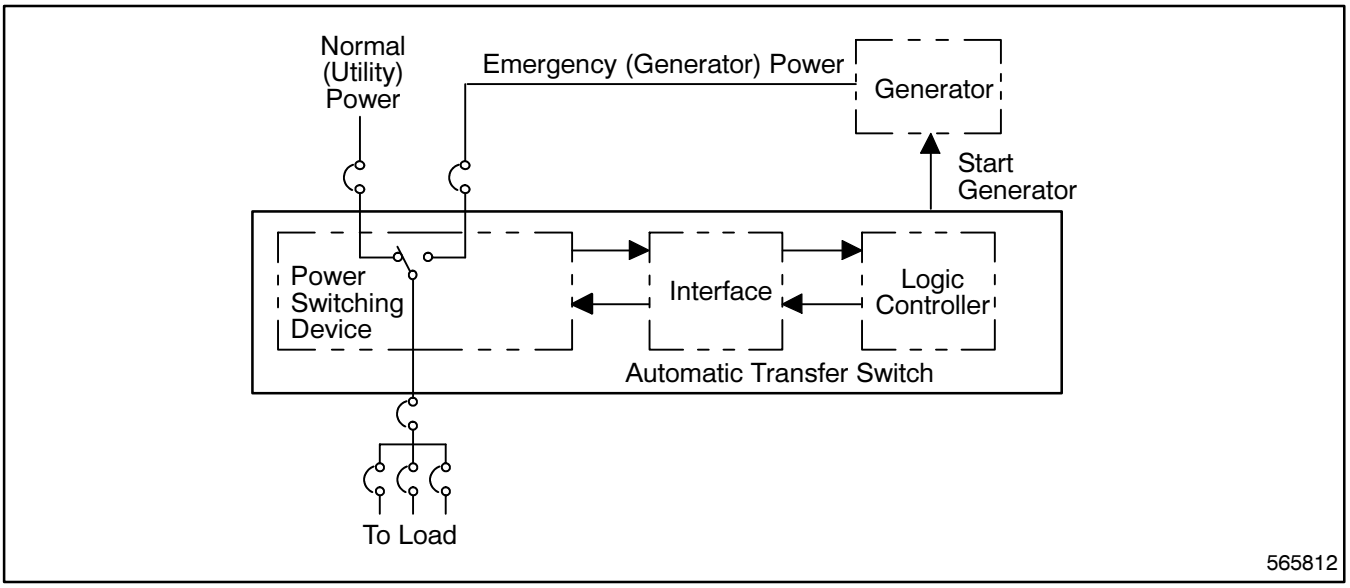


Figure 1-2. Basic Transfer Switch Block Diagram

Ratings

A nameplate is attached to the automatic transfer switch enclosure. See Figure 1-3. The nameplate label includes a factory part number coded to provide characteristic and rating information that affects installation and operation. Copy the part number into the blank spaces provided in Figure 1-4 and then use the tables in Figure 1-4 to interpret the part number.

NOTE

Also copy the part number and serial number from the nameplate into the spaces provided in the Service Assistance Section of the Introduction for use when requesting service or parts.

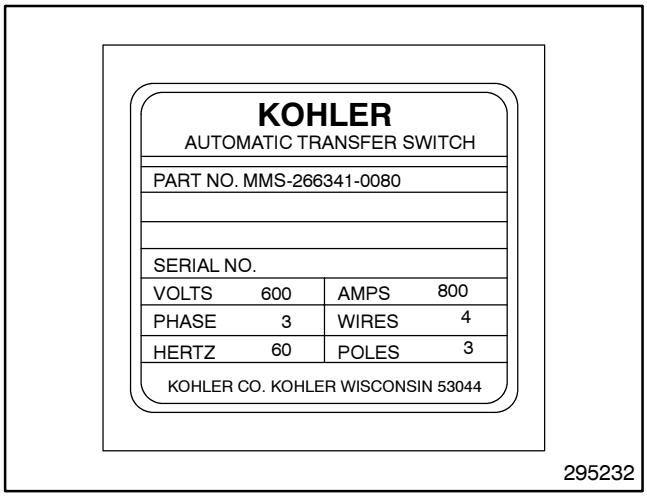
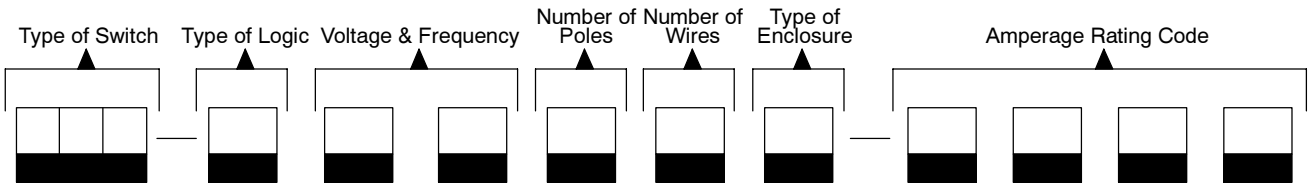


Figure 1-3. Transfer Switch Nameplate

Interpreting a Transfer Switch Part Number

Record the transfer switch part number in the boxes below. The transfer switch part number defines characteristics and ratings as explained in the following key.



Kohler Part Number Key
This key explains the Kohler transfer switch part number system. The sample part number shown is for a standard molded-case switch with E33+ logic rated at 480 volts, 60 hertz, 3-phase, 3-pole, and 4 wires in a NEMA 1 enclosure with an amperage rating of 80 amperes.

SAMPLE PART NUMBER

MMS-266341-0080

Classification of Power Switch
M: Switch or Circuit Breaker
T: Electrically & Mechanically Held
Z: Contactor Style

Type of Power Switch
C: Contactor
E: Electrically Held Contactor
L: Mechanically Held Contactor
M: Molded-Case Circuit Breaker
N: Molded-Case Switch (no protection)

Type of Switch
S: Standard

Type of Logic
2: E33+
4: E33+ with programmed transition

Voltage Code

60: 600 Volt, 60 Hz	66: 480 Volt, 60 Hz
62: 120 Volt, 60 Hz	68: 208 Volt, 60 Hz
63: 220 Volt, 50 Hz	71: 380 Volt, 50/60 Hz
64: 240 Volt, 60 Hz	

Number of Poles
2: 2 pole, 1 phase (MM_, MN_, TE_, TL_, devices will be supplied with 3 poles)
3: 3 pole, 3 phase
6: 4 pole, fully rated switched poles (no overlapping neutral)

Number of Wires
2: 2 wire
3: 3 wire
4: 4 wire

Enclosure
1: NEMA type 1

Amperes
Available sizes vary with the type of switch.

56641

Figure 1-4. Model Number Description

Specifications

The specifications listed herein are for the E33+ logic controller. See the respective power switching device manual for its specifications.

Standard Features

- Transfer switch uses proven solid-state technology.
- Normal source single-phase voltage sensing is fixed at 70% for dropout and 90% for pickup.
- All printed circuit boards are conformal coated for environmental protection.
- Emergency source single-phase sensing is fixed at 85% of rated voltage and 95% of rated frequency.
- TDEN (Time Delay Emergency to Normal) is fixed at 5 minutes.
- TDES (Time Delay on Engine Start) is fixed at 3.0 seconds.
- The test switch simulates a normal source failure.
- Lamps illuminate to indicate normal or emergency source switch position.
- Lamps illuminate to indicate normal and emergency source availability.
- Automatic and inhibit transfer positions are provided.
- Engine start contacts are provided.

Optional Features

See Section 5. Accessories for details of optional features selected.

- Plant exerciser—7 day no load
- Solid state, 2-amp float, 12 volt
- Solid state, 2-amp float, 24 volt
- 3-phase sensing—normal source

Section 2. Operation

Control Switches and Indicators

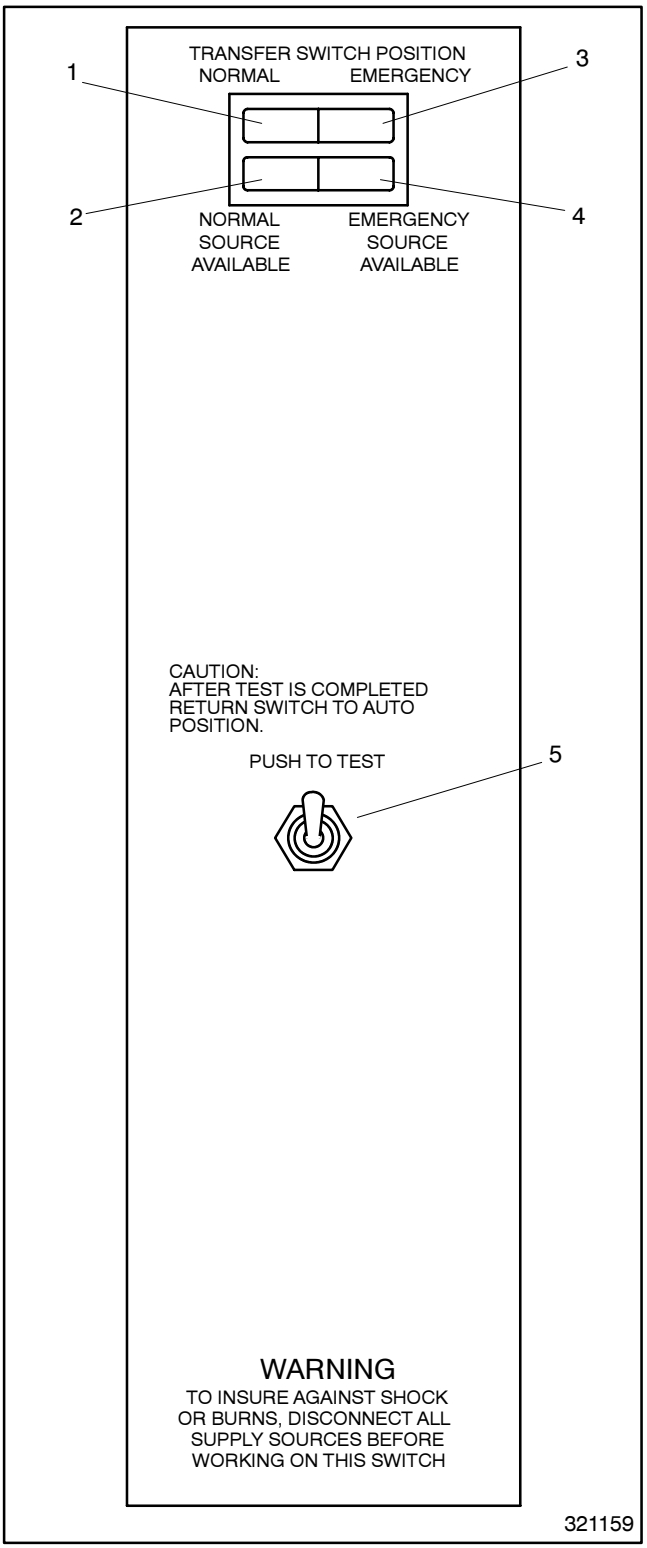


Figure 2-1. Transfer Switch Control Switches & Indicators

Various optional control switches and indicator lamps *may* be present on the transfer switch door. For identification of switches and indicators and an explanation of their function, refer to Figure 2-1 and the following descriptions.

1. **Normal Transfer Switch Position Lamp (green):** Lamp illuminates to indicate that the load is connected to the normal source.
2. **Normal Source Available Lamp (white):** Lamp illuminates to indicate presence of normal source voltage.
3. **Emergency Transfer Switch Position Lamp (red):** Lamp illuminates to indicate that load is connected to the emergency source.
4. **Emergency Source Available Lamp (white):** Lamp illuminates to indicate presence of emergency source voltage.
5. **Test Switch:** Normal position allows automatic transfer switch operation. *Test* position signals generator set to start.

Sequence of Operation

Normal Source Failure

Load transfer to the emergency source automatically begins when the voltage sensing circuit detects reduced voltage or total loss of the normal source. Relay K2, located on the main logic circuit board, will de-energize whenever the voltage level falls below the preset dropout point (70%) of line voltage. See Figure 2-3.

The time delay engine start relay (TDES) begins its engine start timing cycle as the K2 relay deenergizes. The TDES relay is located on the main logic panel. See Figure 2-3. Standard time delay is factory set at 3.0 seconds. TDES relay is a time delay on dropout to override momentary outages. This delay prevents nuisance starting of the generator set. If the normal source voltage returns above the voltage dropout setting before the time delay expires the K2 and TDES energize causing the timing cycle to reset to zero.

TDES relay deenergizes after the time delay and signals the generator set to start. The emergency voltage and frequency circuits monitor the emergency source. The K1 relay will energize when the emergency source voltage and frequency reach the pickup points (85% voltage and 95% frequency). See Figure 2-3. If the emergency source is immediately available, the sensing circuits will accept immediately.

When the emergency source is acceptable, the emergency relay (ER) relay is energized. The ER relay will cause immediate transfer to the emergency source or cause the opening of the normal source and/or a transfer to the emergency source after a time delay (TDOE) if the switch is equipped with an optional program transition function. See Figure 2-1.

When the ER relay or the TDOE relay (if equipped) energizes the switch transfers load to the emergency source. The transfer switch is now supplying the load from the emergency source and will remain in this position until the normal source is restored.

Normal Source Restoration

Load transfer to the normal source automatically begins when the voltage sensing circuit detects restoration of the normal source. The voltage level must rise above the preset pickup point (90%) on all phases before the circuit will accept the normal source again.

When the normal source is accepted by the voltage sensing circuit the K2 relay is energized. After a time delay period (TDEN) the NR relay energizes. This time delay ensures that the normal source has stabilized before reconnection of vital loads. An optional program transition will stop the transition in the off position for an adjustable time (TDON). If the emergency source fails during this timing cycle the K1 relay drops out and the load is immediately transferred to the normal source if acceptable.

The K1 relay energizes and after the TDEN delay the NR relay energizes. The ER relay is dropped out. The switch transfers load back to the normal source. The transfer switch is in the normal position.

The logic circuitry energizes the TDES relay, which signals the generator set to shut down. All circuits are reset for any future normal source failure.

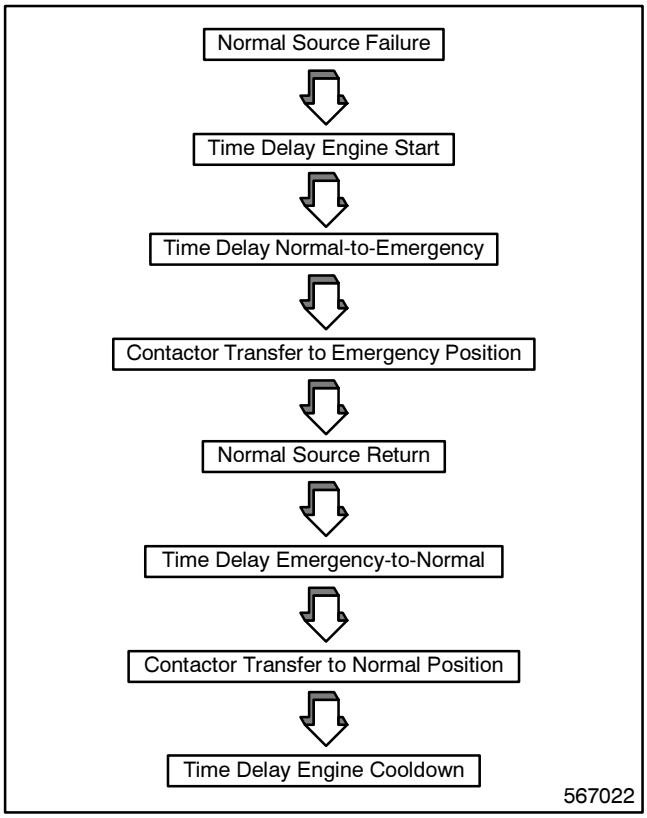
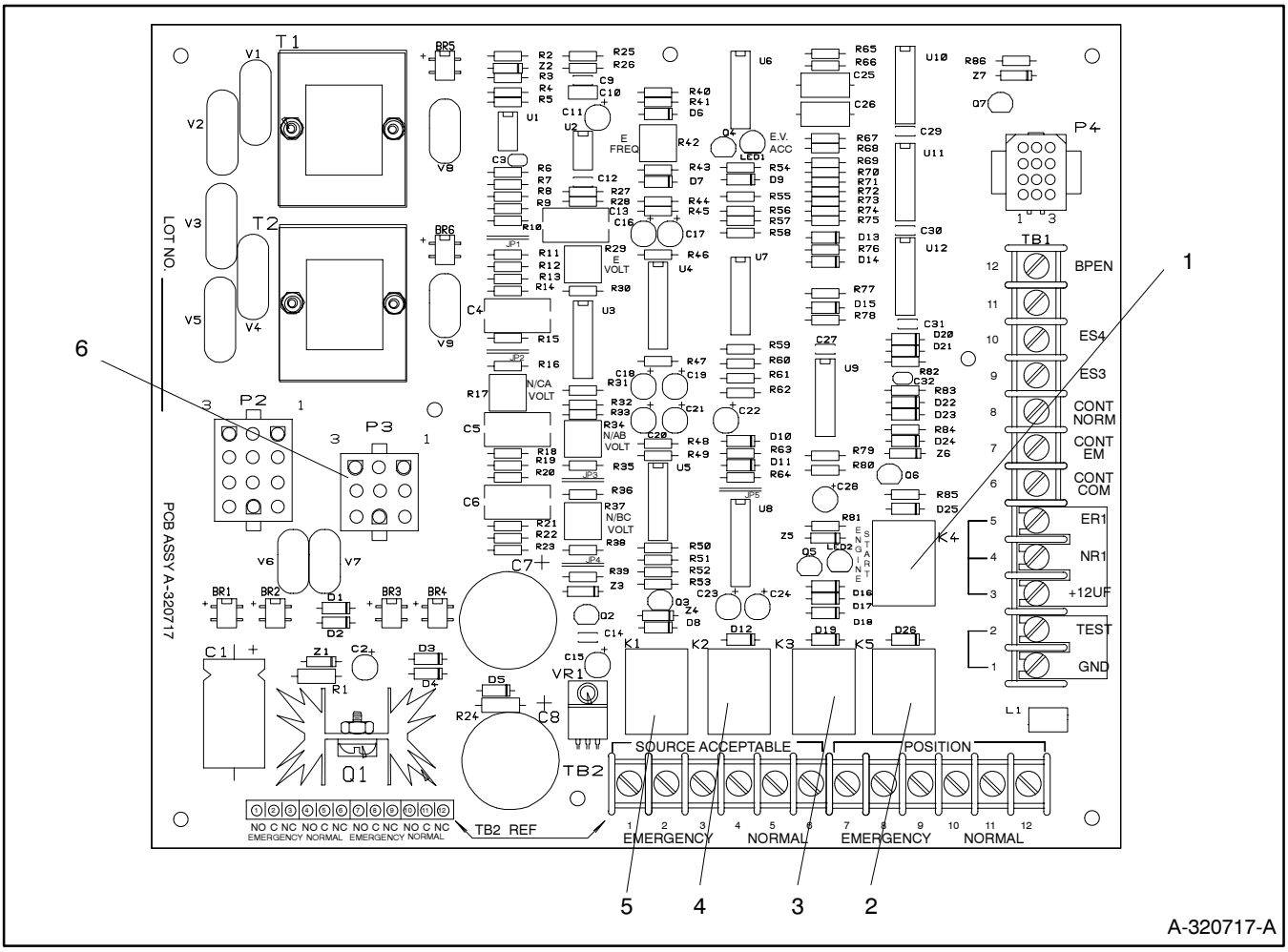
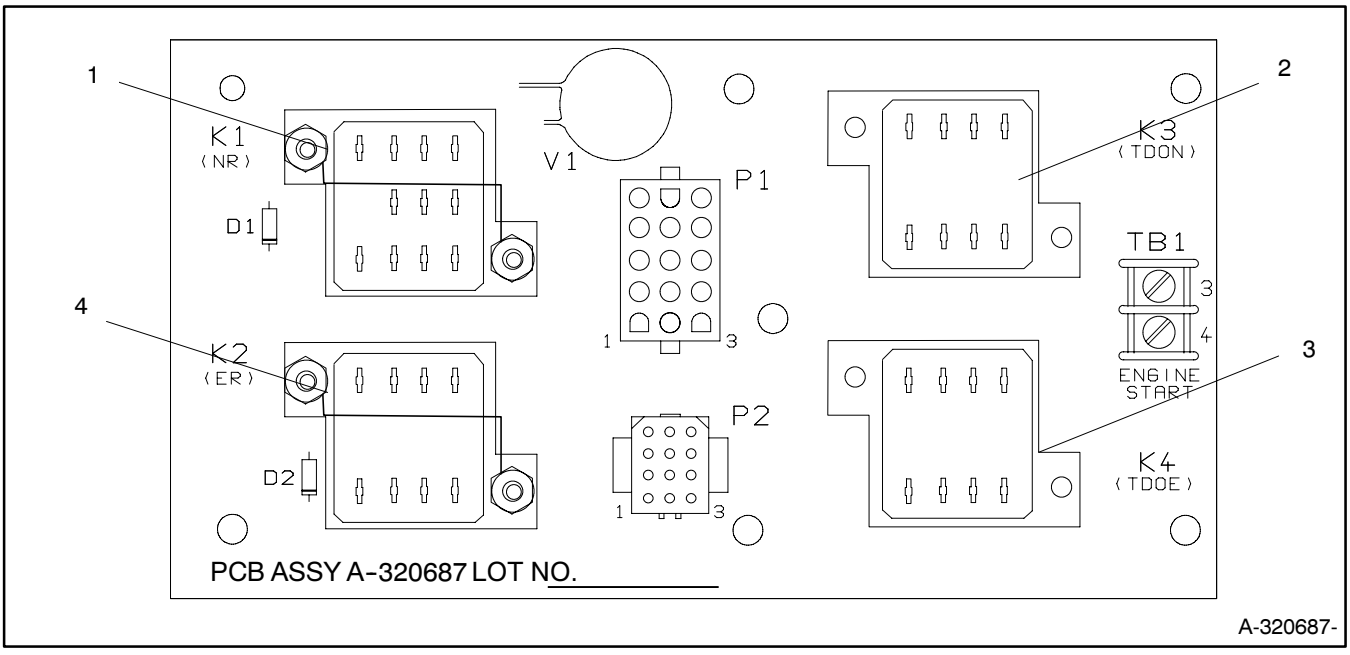


Figure 2-2. Logic Board Operation



1. Time Delay Engine Start (TDES) Relay
2. Normal Position Relay (K5)
3. Emergency Position Relay (K3)
4. Normal Source Acceptable Relay (K2)
5. Emergency Source Acceptable Relay (K1)
6. Optional 3-Phase Sensing Connection

Figure 2-3. Main Logic Circuit Board



1. NR Relay
2. TDON Relay
3. TDOE Relay
4. ER Relay

Figure 2-4. Interface Circuit Board

Main Circuit Board Voltage Adjustments

The main circuit board contains a normal source undervoltage circuit. The voltage values are factory set and should not need adjustment. Single phase sensing is fixed at 70% dropout and 90% pickup. Three phase sensing on normal requires an optional accessory. See Section 5.

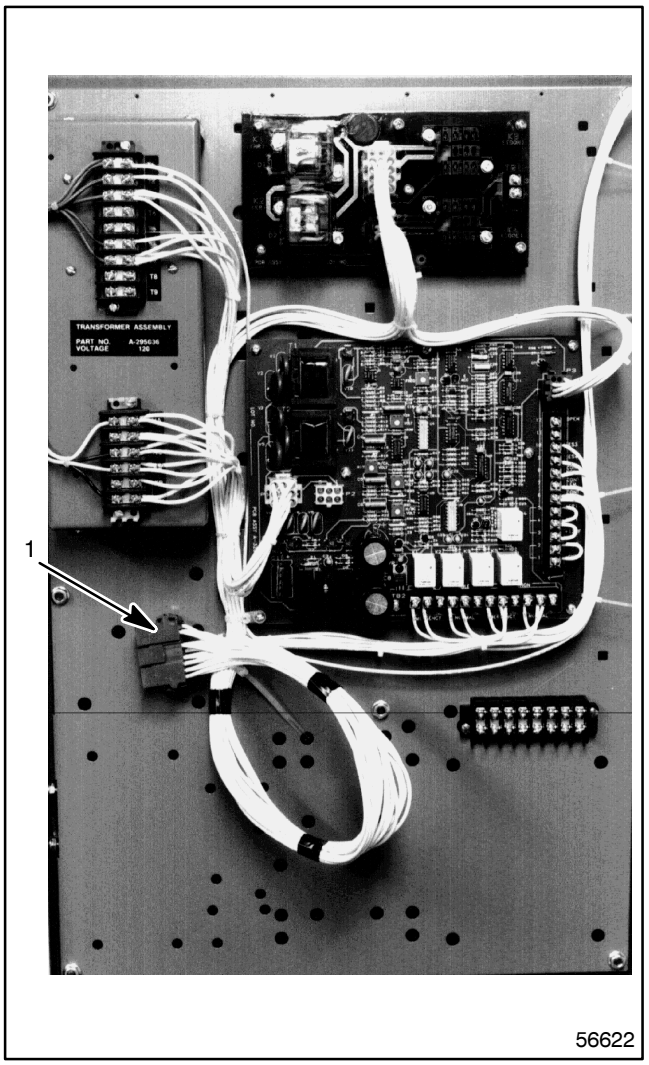
Single phase sensing on the emergency source is fixed at 85% voltage and 95% frequency.

To Disconnect The P1 Plug

1. If the transfer switch is in the normal position, place the generator set start switch in the OFF position, and then open the emergency-source circuit breaker.
2. If the transfer switch is in the emergency position, open the normal-source circuit breaker and place the generator set start switch in the TEST position.
3. Separate the in-line disconnect plug by grasping and squeezing the plug. Do NOT pull on the wires. See Figure 2-5.

To Reconnect The P1 Plug

1. Engage the in-line disconnect plug by grasping the connectors and pressing together.
2. If the transfer switch is in the normal position, place the generator set start switch in the AUTO position, and then close the emergency-source circuit breaker.
3. If the transfer switch is in the emergency position, close the normal-source circuit breaker. The load will automatically retransfer after a time delay to the normal source, if available. For immediate retransfer, open and then reclose the emergency-source circuit breaker. Place the generator set start switch in the AUTO position.



1. In-Line Disconnect Plug (P1)

Figure 2-5. In-line Disconnect Plug

Voltage Checks

NOTE

Perform voltage checks in the order given to avoid damaging the switch.

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Do not open enclosure until all power sources are disconnected.

(600 Volt and above)

Hazardous voltage can cause severe injury or death. Short circuits can cause bodily injury and/or equipment damage**.** Do not contact electrical connections with tools or jewelry while adjustments are made. Remove wristwatch, rings, and jewelry that can cause short circuits.

⚠ WARNING

Hazardous voltage.
Can cause severe injury or death.

Disconnect power sources before servicing. Barrier must be installed after adjustments, maintenance, or servicing.

(under 600 Volt)

Hazardous voltage can cause severe injury or death. Whenever electricity is present, there is the hazard of electrocution. Open main circuit breaker on all power sources before servicing equipment. Electrically ground the generator set and electrical circuits when in use. Never come into contact with electrical leads or appliances when standing in water or on wet ground, as the chance of electrocution is increased under such conditions.

Hazardous voltage can cause severe injury or death. Disconnect inner panel harness at in-line connector. This will deenergize circuit board and logic circuitry, but allow transfer switch to continue to supply utility power to necessary lighting and equipment. Hazardous voltage will exist if any accessories mounted to inner panel are NOT wired through the inner panel harness and deenergized by in-line connector separation. Such accessories are at line voltage.

Safety decals are affixed to the transfer switch in prominent places to advise the operator or service technician of potential hazards. The decals are reproduced here to improve operator recognition. For a further explanation of decal information, refer to the safety precautions throughout this manual. Before operating or servicing the transfer switch, be sure you understand the messages of these decals. Replace decals if missing or damaged.

Read and understand all instructions on installation drawings and labels affixed to the switch. Note any optional accessories that have been furnished with the switch and review their operation.

Check the transfer switch nameplate for rated voltage. The voltage should be the same as normal and emergency line voltage and emergency line voltage.

1. Verify power is off then separate the power switch device control in-line disconnect plug (P1) if not already done. See Figure 2-5.
2. Close the normal source line circuit breaker.
3. Use an accurate voltmeter to check for rated voltage phase-to-phase and phase-to-neutral voltages. Check phase rotation at the power switching device's normal-source terminals.
4. Close the emergency source line circuit breaker.
5. Manually start the generator set using the engine control switch on the generator set controller.
6. Use an accurate voltmeter to check for rated voltage phase-to-phase and phase-to-neutral voltages. Check phase rotation at the contactor's emergency-source terminals.

7. If the emergency source is not at rated voltage, adjust the generator voltage regulator following the generator set manufacturer's instructions. The automatic transfer switch will respond only to rated voltage and frequency specified on the nameplate. Check phase rotation; it should be the same as that of the normal source.
8. Shut down the generator set using the engine control switch on the generator set controller. Remove the normal source and reconnect the power switch device control in-line disconnect plugs. See Figure 2-5. Wait until the time delay engine cooldown (TDEC, if equipped) has completed timing per the factory setting. After the TDEC has completed timing, the generator set controller's engine control switch can be placed in the AUTO position.

Electrical Operation Test

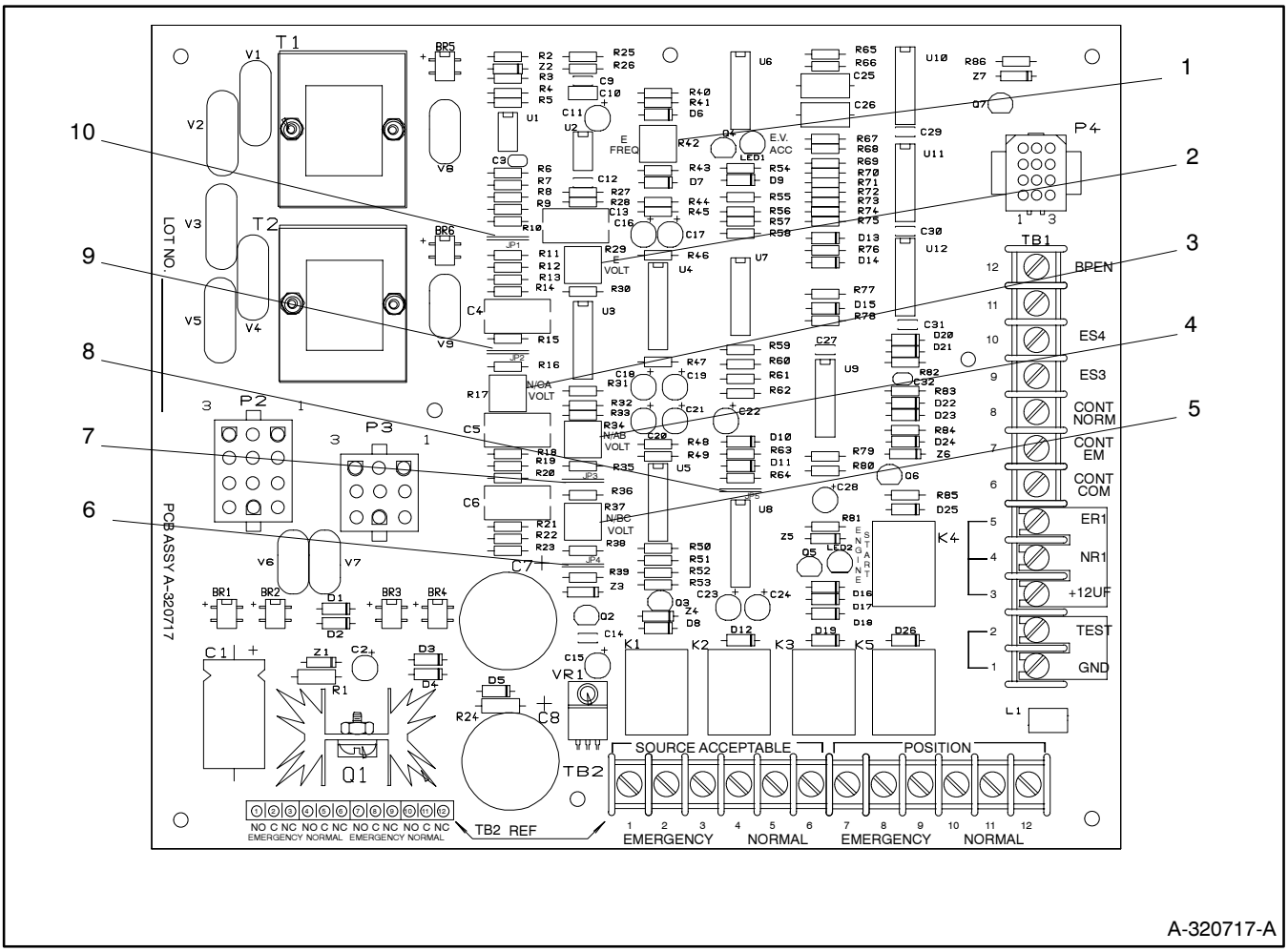
9. Place the transfer switch in the Normal position. The following procedure will check the electrical operation of the automatic transfer switch.
10. Place the Test switch (if so equipped) in the TEST position. See Figure 2-1. The generator set will start and run after the Time Delay Engine Start (TDES) relay times out.
11. The transfer switch will transfer to the emergency position. The transfer will occur after the Normal-to-Emergency Time Delay (TDNE) relay times out.
12. Move the door-mounted test switch back to the normal position. The transfer switch will retransfer to normal after the emergency-to-normal time delay relay times out.
13. Time Delay Engine Cooldown (TDEC) allows the engine to continue running without load for an additional period. The transfer switch TDEC will complete timing before any TDEC function in the generator set controller begins timing.
14. Close load circuit breaker(s) when loads may be energized.

NOTE

If you connect the transfer switch in-line disconnect plugs (P1) together while the generator controller's master switch in the AUTO position, the generator set will IMMEDIATELY start and run until the generator set controller's cooldown timer has completed timing.

This completes functional tests of the transfer switch. Place the generator set starting control in the automatic position.

Section 3. Circuit Board Adjustment



1. R42
2. R29
3. R17
4. R34
5. R37
6. Jumper 4
7. Jumper 3
8. Jumper 5
9. Jumper 2
10. Jumper 1

Figure 3-1. Main Logic Circuit Board

⚠ WARNING

Hazardous voltage.
Can cause severe injury or death.

Disconnect power sources before servicing. Barrier must be installed after adjustments, maintenance, or servicing.

(under 600 Volt)

Hazardous voltage can cause severe injury or death. Disconnect inner panel harness at in-line connector. This will deenergize circuit board and logic circuitry, but allow transfer switch to continue to supply utility power to necessary lighting and equipment. Hazardous voltage will exist if any accessories mounted to inner panel are NOT wired through the inner panel harness and deenergized by in-line connector separation. Such accessories are at line voltage.

Main Circuit Board Jumper Wire Configuration

The E33+ logic board uses five jumpers to configure the voltage range and number of phases sensed on the normal source. See Figure 3-2 for a list of the jumper numbers and their functions.

Jumper Numbers	Jumper Installed	Jumper Removed
Jumpers 1-4	Calibrated for a voltage from 0 to 240 volts	Calibrated for a voltage from 241 to 600 volts
Jumper 5	Configured for single phase sensing	Configured for three phase sensing

Figure 3-2. Main Circuit Board Jumper Wire Configuration

Main Circuit Board Voltage Adjustment

The E33+ logic board has five pots used to adjust the voltage and frequency pickup points. See Figure 3-3 for a list of the pots and their functions.

Adjustment Potentiometers	Function Adjusted
R17	Normal source voltage adjustment (A–C)
R34	Normal source voltage adjustment (A–B)
R37	Normal source voltage adjustment (B–C)
R29	Emergency source voltage adjustment (A–C)
R42	Emergency source frequency adjustment

Figure 3-3. Main Circuit Board Voltage Adjustment

Normal Source

The E33+ logic board See Figure 3-1 contains a normal source undervoltage circuit that is fixed at 70% dropout and 90% pickup. The voltage values are factory-set and should not need adjustment unless the voltage rating of the switch has changed. The following steps explain the procedure for adjusting the pickup voltage.

NOTE

Use a variable AC power supply or generator set to establish the voltage and frequency needed to calibrate the logic board. Refer to Figure 3-2 for jumper configuration.

1. Turn the normal and emergency source circuit breakers off.
2. Disconnect the normal, emergency, and load cables from the transfer switch.
3. Connect the adjustable voltage source to the transfer switch normal terminals. The voltage source must have the same frequency rating as the transfer switch.
4. Check jumpers 1–4 for the correct voltage range configuration. Refer to Figure 3-2.
5. Check jumper five to see if single- or three-phase monitoring is selected. Refer to Figure 3-2.

For Single-Phase Monitoring

1. Turn pot R17 completely counterclockwise.
2. Set the adjustable voltage supply to 90% of rated voltage and 100% of rated frequency.
3. Place an ohmmeter across terminals TB2-4 and TB2-5. The ohmmeter will show infinite resistance.
4. Turn pot R17 slowly clockwise until the ohmmeter shows no resistance.
5. The logic will automatically adjust the dropout point to 70% of the rated voltage.

For Three-Phase Monitoring

1. Turn pot R17 completely counterclockwise and pots R34 and R37 completely clockwise.
2. Set the adjustable voltage supply to 90% of rated voltage and 100% of rated frequency.
3. Place and ohmmeter across terminals TB2-4 and TB2-5. The ohmmeter will show infinite resistance.
4. Turn pot R17 slowly clockwise until the ohmmeter shows no resistance.
5. Turn pot R34 completely counterclockwise. The ohmmeter will show infinite resistance.
6. Turn pot R34 slowly clockwise until the ohmmeter shows no resistance.
7. Turn pot R37 completely counterclockwise. The ohmmeter will show infinite resistance.
8. Turn Pot R37 slowly clockwise until the ohmmeter shows no resistance.
9. The logic will automatically adjust the dropout point to 70% of the rated voltage.

Emergency Source

The E33+ logic board Figure 3-1 contains an emergency source undervoltage circuit. The voltage values are factory-set and should not need adjustment unless the voltage rating of the switch has changed. The emergency source can sense only single phase. Sensing is fixed at 85% dropout for voltage and 95% for frequency. The following steps explain the procedure for adjusting the pickup voltage and frequency.

NOTE

Use a variable AC power supply or generator to establish the voltage and frequency needed to calibrate the logic board.

1. Turn the normal and emergency source circuit breakers off.
2. Disconnect the normal and emergency power cables from the transfer switch.
3. Connect the adjustable voltage source to the transfer switch normal terminals. The voltage source must have the same frequency rating as the transfer switch.
4. Check jumpers 1-4 for the correct voltage range configuration.
5. Turn pot R29 completely counterclockwise.
6. Adjust the voltage supply to 85% of rated voltage and 95% of rated frequency.
7. Turn pot R29 slowly clockwise until LED1 lights.
8. Place an ohmmeter across terminals TB2-1 and TB2-2. The ohmmeter will show infinite resistance.
9. Adjust the voltage supply to 95% of rated voltage and 100% of rated frequency.
10. Turn pot R42 slowly clockwise until the ohmmeter shows no resistance.

This completes the adjustments of the E33+ pots.

Notes

Section 4. Controller Troubleshooting

General Troubleshooting Information

1. Contactor must be in the normal position to allow the generation of an engine start signal.
2. The test switch is a normally closed switch. Short terminals TB1-1 and TB1-2 on the logic board for normal operation of the logic controller. When the short is removed, the normal sensing voltage inputs are removed from the controller logic board.
3. Terminal TB1-6 on the logic board (contactor common) provides a ground connection to the contactor's auxiliary switch (used for switch position sensing). If this line is not grounded, the engine start relay (K4) may not dropout.

Logic Board Troubleshooting

Use the following troubleshooting flowchart to assist in the troubleshooting and repair of common transfer switch problems.

Generator will not start when power fails or with the test switch pressed.

Step	Test Procedure	Yes Action	No Action
A1	Is the engine start, LED2 illuminated?	Proceed to step A8	Proceed to step A2
A2	Is the contactor in the normal position?	Proceed to step A3	Move contactor to the normal position.
A3	Is the normal power source available?	Proceed to step A4	Connect or restore the normal source.
A4	Is there 24 vac at transformer terminals T2 and T3?	Proceed to step A5	Check transformer assembly for open circuits, replace if necessary.
A5	Is the ribbon cable in plug P2 on the logic board connected?	Proceed to step A6	Install ribbon cable in plug P2.
A6	Is there 12 vdc between terminal TB1-3 and terminal TB1-1 on the logic board?	Proceed to step A7	Replace the logic board.
A7	Is terminal TB1-8 on the logic board grounded?	Replace the logic board.	Check the wiring between the logic board and the contactor.
A8	Does the generator set start when the test switch is in the TEST position?	Proceed to step A9	Proceed to step A10
A9	Is the normal source voltage below the pickup setpoint, or are the normal voltage jumpers cut? See main circuit board jumper wire configuration in Section 3, Main Circuit Board Adjustments.	Readjust the voltage setpoint pots or correct the jumpers. See Section 3, Main Circuit Board Adjustments.	Replace the logic board.
A10	Place a jumper between terminals TB1-10 (ES4) and terminal TB1-9 (ES3) on the logic. Did the set generator start?	Proceed to step A11	Check the wiring between the logic board and the generator set.
A11	Remove the leads from terminal TB1-1 and terminal TB1-2 on the logic board. Did the generator set start?	Proceed to step A12	Replace the logic board.
A12	Do the leads to the test switch have continuity between them?	Repair short in wiring or replace wiring to test switch.	Replace the test switch.

Generator runs, but transfer switch does not transfer load to the emergency source during power failure or with the test switch depressed.

Step	Test Procedure	Yes Action	No Action
B1	Does LED1 illuminate when the generator set is running?	Proceed to step B2	Proceed to step B4
B2	With a frequency meter check the frequency at terminals EA and EC of the transformer assembly. Is the frequency between 95% and 100% of the transfer switch rated frequency?	Proceed to step B3	Check and adjust generator set for rated voltage and frequency. See generator set operation manual.
B3	Adjust the emergency frequency setpoint. See Main Circuit Board Voltage Adjustments, Emergency Source in Section 3. Did the adjustment cause the emergency source available relay to energize?	Operate switch as normal.	Replace the logic board.
B4	Check the generator voltage at terminals EA and EC of the transformer assembly. Is the voltage the same as the transfer switch rated voltage?	Proceed to step B5	Check and adjust generator. See generator set operation manual.
B5	Check the voltage at terminals T6 and T7 of the transformer assembly. Is there between 24 and 26 vac?	Proceed to step B6	Replace the transformer assembly.
B6	Is the wiring harness between the transformer and the logic board free of any physical damage?	Proceed to step B7	Repair or replace the wiring harness from the transformer to the logic board.
B7	Adjust the emergency voltage setpoint. See Main Circuit Board Voltage Adjustments, Emergency Source in Section 3. Did the adjustment cause the emergency source available relay to energize?	Operate switch as normal.	Replace the logic board.

Transfer switch will not transfer back to normal.

Step	Test Procedure	Yes Action	No Action
C1	Is the test switch in the TEST position?	Move the switch to the auto position. Proceed to step C2.	Proceed to step C3
C2	After the TDEN finished timing did the transfer switch return to the normal source?	Troubleshooting complete.	Proceed to step C3
C3	Check for rated switch voltage at terminals NA and NC of the transformer assembly. Is the voltage correct?	Proceed to step C4	Proceed to step C6
C4	Is there between 24 and 26 vac between terminal T2 and terminal T3 of the transformer assembly?	Proceed to step C5	Replace the transformer assembly.
C5	Adjust normal voltage setpoint. See Main Circuit Board Voltage Adjustments, Normal Source in Section 3. Did the adjustment cause the normal source available relay to energize?	Operate switch as normal.	Replace the logic board.
C6	Check the wiring harness from transformers to the power switching device for an open circuit. Is there an open circuit?	Repair or replace wiring harness from the transformers to the power switching device.	Normal source is not available.

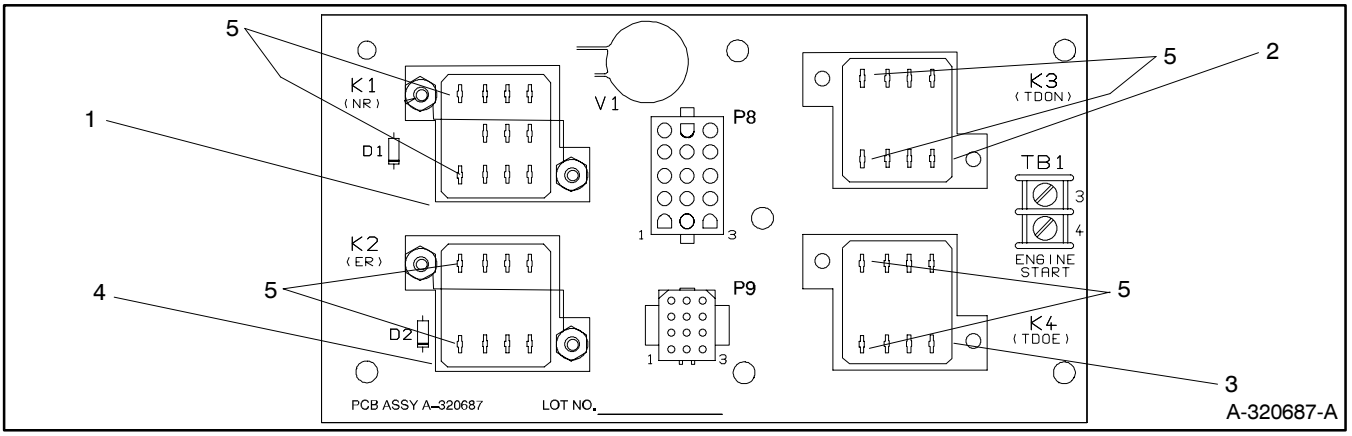
Interface Relay Board Troubleshooting

NOTE

Before using the following troubleshooting procedure, complete the logic board troubleshooting flowchart procedures.

Transfer switch will not transfer to emergency.

Step	Test Procedure	Yes Action	No Action
A1	Is the voltage at the emergency transformers correct? See Figure 4-2 and Figure 4-3.	Proceed to step A2	Proceed to step A10
A2	Does the ER relay (K2) pull in?	Proceed to step A3	Proceed to step A8
A3	Does the ATS disconnect the load from the normal source?	Proceed to step A4	Proceed to step A6
A4	Remove the TDOE relay (K4). Is there 25.5 to 26.5 vac on the coil contacts? See Figure 4-1.	Proceed to step A5	Reinstall TDOE relay (K4) and proceed to step A10.
A5	Replace the TDOE relay and retest. Is the transfer switch working?	Troubleshooting complete.	Proceed to step A11
A6	Disconnect plug P8 on the interface relay board. Is there continuity between pins P8-1 and P8-2?	Proceed to step A7	Replace interface relay board.
A7	Is the wiring harness from the interface relay board to the power switch wired correctly and free of any physical damage?	Refer to the power switch troubleshooting section of the switch's troubleshooting manual.	Repair or replace wiring harness from interface relay board to the power switch.
A8	Remove ER relay (K2). Is there 12 vdc across the coil contacts in the relay socket? See Figure 4-1.	Replace the ER relay.	Proceed to step A9
A9	Is the wiring harness from the logic board to the interface relay board wired correctly and free of any physical defects?	Replace logic board.	Repair or replace wiring harness from logic board to interface relay board.
A10	Disconnect plugs P8 and P9 from the interface relay board. Is the voltage between pins P8-6 to P9-6, 25.5 to 26.5 vac?	Proceed to step A11	Test the voltage at the transformer's assembly. Repair or replace as necessary.
A11	Is there any damage to the interface relay board (burn traces, resistors, etc.)?	Replace the interface relay board.	Proceed to step A12
A12	Is the TDOE relay functioning?	Replace the interface relay board.	Replace the TDOE relay.



1. NR Relay
2. ER Relay
3. TDON Relay
4. TDOE Relay
5. Coil Contacts

Figure 4-1. Interface Relay Board

Transfer switch will not transfer to normal.

NOTE

Before using the following troubleshooting procedure, complete the logic board troubleshooting flowchart procedures.

Step	Test Procedure	Yes Action	No Action
B1	Is the voltage at the emergency transformers correct? See Figure 4-2 and Figure 4-3.	Proceed to step B2	Proceed to step B10
B2	Does the NR relay (K1) pull in?	Proceed to step B3	Proceed to step B8
B3	Does the ATS disconnect the load from the emergency source?	Proceed to step B4	Proceed to step B6
B4	Remove the TDON relay (K3). Are there between 25.5 and 26.5 vac at the coil contacts? See Figure 4-1.	Proceed to step B5	Reinstall TDON relay (K3) and proceed to step B10
B5	Replace the TDON relay (K3) and retest. Is the transfer switch working correctly?	Troubleshooting complete.	Proceed to step B7
B6	Disconnect P8 on the interface relay board. Is there continuity between pins P8-1 and P8-2?	Proceed to step B7	Replace interface relay board.
B7	Is the wiring harness from the interface relay board to the power switch wired correctly and free of any physical damage?	Refer to the power switch troubleshooting section of the switch's troubleshooting manual.	Repair or replace wiring harness from interface relay board to the power switch.
B8	Remove NR relay (K1). Are there 12 vdc across the coil contacts in the relay socket? See Figure 4-1.	Replace the NR relay.	Proceed to step B9
B9	Is the wiring correct from the logic board to the interface relay board?	Replace logic board.	Repair or replace wiring harness from logic board to interface relay board.
B10	Disconnect plugs P8 and P9 from the interface relay board. Is the voltage between pins P8-7 to P9-7, 25.5 to 26.5 vac?	Proceed to step B11	Test the voltage at the transformer's assembly. Repair or replace as necessary.
B11	Is there any damage to the interface relay board (burn traces, resistors, etc.)?	Replace the interface relay board.	Proceed to step B12
B12	Is the TDON relay functioning properly?	Replace the interface relay board.	Replace the TDON relay.

With Normal Power Energized	
Terminals	VAC
NA-NC	Line to Line
NB-NC	Line to Line
NC-NA	Line to Line
T2-T3	25.75-26.25
T1-T2	12.75-13.25
T1-T3	12.75-13.25
T1-T4*	12.75-13.25
T1-T5*	12.75-13.25

* Only supplied on units with three-phase sensing (optional accessory DA-26).

Figure 4-2. ATS Transformer Voltage Data

With Emergency Power Energized	
Terminals	VAC
EA-EC	Line to Line
T6-T7	25.48-26.52
T1-T6	12.74-13.26
T1-T7	12.74-13.26

Figure 4-3. ATS Transformer Voltage Data

Section 5. Accessory Troubleshooting

600 Volt and Above

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Do not open enclosure until all power sources are disconnected.

(600 Volt and above)

⚠ DANGER

Hazardous voltage.
Will cause severe injury or death.

Disconnect power sources before servicing. Barrier must be installed after adjustments, maintenance, or servicing.

(600 Volt and above)

Hazardous voltage can cause severe injury or death. Whenever electricity is present, there is the hazard of electrocution. Open main circuit breaker on all power sources before servicing equipment. Electrically ground the generator set and electrical circuits when in use. Never come into contact with electrical leads or appliances when standing in water or on wet ground, as the chance of electrocution is increased under such conditions.

Hazardous voltage can cause severe injury or death. Short circuits can cause bodily injury and/or equipment damage**.** Do not contact electrical connections with tools or jewelry while adjustments are made. Remove wristwatch, rings, and jewelry that can cause short circuits.

Hazardous voltage can cause severe injury or death. To prevent the possibility of electrical shock, disconnect harness plug before installing any accessories involving connection to transformer assembly primary terminals 76, 77, 78, and 79. Terminals are at line voltage!

Figure 5-1 shows the relationship between the logic board main functions and the effect that different accessories can have on those functions.

DA Option	Option Description	Accessory Effects			
		Transfer Normal to Emergency	Transfer Emergency to Normal	Engine Start	Engine Shutdown
23-P	Plant Exerciser			X	X
24-XX-A,B	Battery Charger			X	
26	Normal Source Three Phase Sensing	X	X	X	

Figure 5-1. Accessory Troubleshooting Chart

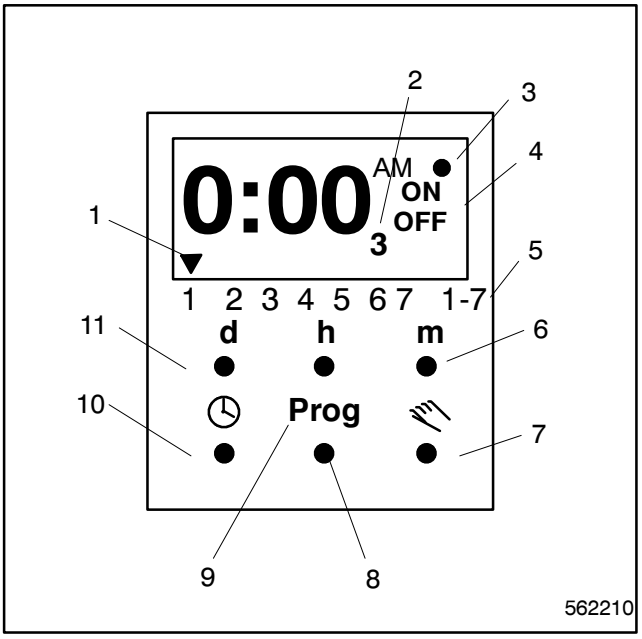
Optional Features Troubleshooting

Accessories 23-P: 7-Day, Solid-State Exercise Timer

Accessory 23-P signals the generator set to run unloaded for the set time period. Timer does not simulate a normal source failure. The transfer switch is not affected.

Specifications

Feature	Range
Switching Capacity	10A, 250V
Switching Interval	1 minute
Permissible Ambient Temperature	-10C to +45C



1. Day of Week
   1 = Monday 4 = Thursday
   2 = Tuesday 5 = Friday
   3 = Wednesday 6 = Saturday
   7 = Sunday
2. Response Time Number for the weekday indicated (1 ON, 1 OFF, 2 ON, 2 OFF, etc.) ☰ OFF Holiday program
3. Dot indicates permanent override control ON or OFF
4. Switch Position ON or OFF
5. Programmed Daily display, 1-7
6. Minute Setting
7. Override and Permanent Control
8. Program Entry/Recall
9. Hours/Holiday Setting
10. Time Setting
11. Weekday Setting

Figure 5-2. Plant Exerciser Features

Adjustment

See Figure 5-2 for operational information. Remove the transparent timer cover when making adjustments. Replace the cover when adjustment is complete.

NOTE

The display will remain for about 40 seconds after an entry is interrupted (postponed) or finished. Then it will switch to normal automatic operation.

To Reset & Clear Memory:

1. The power supply must be connected to the plant exerciser before setting the clock timer. Check to see that the in-line disconnect plug attaching the contactor to the logic panel is connected.
2. Press the following four keys simultaneously to reset the timer's programming. This will clear the memory and permit new programming. Press the **d**, 🕓 , **m,** and ✋ buttons.

Setting Day of Week and Time

1. During the day and time setting procedure, hold down the 🕓 button.

NOTE

This timer may be set as either a seven-day or a one-day timer. To set the generator set to run during certain hours of every day, refer to Entering Daily Time Periods following.

2. Press the **d** button to select the weekday. The arrow on the display will move to indicate the day of the week selected (1-7).
3. Set the time by pressing the **h** button or the **m** button, for hours or minutes. If the button is depressed for more than one second, the quick sequence will allow faster time change. When nearing the desired time, release the button to use the slow sequence so the desired time is not passed.

NOTE

Some earlier models may use a 24-hour clock. Use military time when setting.

4. After the time- and day-setting procedure is complete, release the 🕓 button.

Daylight Savings Time Adjustment

If a semiannual time change applies in the area, use the following procedure to conveniently set the hour without having to completely reset the timer.

1. To add 1 hour, press the **d** and the **h** buttons simultaneously.
2. To subtract 1 hour, press the **d** and the **m** buttons simultaneously.

Setting Exercise Start and Stop Times

A maximum of four time periods (four start and four stop times) is programmable for each day of the week. A maximum of 28 time periods (28 start and 28 stop times) is possible. For exercising the generator set, only one start and stop period per week is usually necessary.

1. Decide upon a convenient day and time to test run the generator set that will not disturb usual work or living routines. It is recommended that exercising be done when observation by a responsible person is possible.

   NOTE

   If the setting procedure is interrupted, postponed, or finished, the display will show the actual time after approximately 40 seconds. The system will then switch to normal automatic operation.

2. Press the **Prog** button once. Press the **d** button. The display will show an arrow above 1 which indicates Monday (2 = Tuesday, 3 = Wednesday, etc.). Press the **d** button until the arrow is above the decided weekday. Press the button to store the selected day. Start/stop commands can now be entered for the selected day.
3. When ON is indicated on the right-hand side of the display, set the START time by pressing the **h** button and/or the **m** button.
4. Store the START time command by pressing the **Prog** button. This command places the program in the OFF mode.
5. When OFF is indicated on the right side of the display, press the **d** button until the arrow is above the decided weekday. Press the button to store the selected day. Set the STOP time by pressing the **h** button and/or the **m** button.
6. Store the STOP time command by pressing the **Prog** button. This command places the program in the ON mode for the next set of response times.
7. Now set periods 2, 3, and 4 of the same weekday using the same procedure, if required. To override/cancel this function and go to another weekday, press the **d** button until the required weekday is shown.
8. If programming is complete, press the button. The timer is now set to function as programmed.

Entering Daily Time Periods

The timer may be set to run the generator set during certain hours of every day.

After the timer's memory has been reset and cleared, the timer can be set as a one-day timer. Up to six time periods (6 start and 6 stop times) can be set in this mode.

To use the daily-program mode, do not set a current day of the week. Rather, leave the day pointer above the **1-7**. Set the ON/OFF times following steps 3-8 in Setting Exercise Start and Stop Times procedure.

Program Recall/Check

1. To check or verify the programmed START/ON and STOP/OFF times, simultaneously press the **Prog** button and **d** button for each respective day. Press the **Prog** button to display START/ON and STOP/OFF response times. Daily response times are displayed for each day following the normal program locations (1 ON, 1 OFF, 2 ON, 2 OFF, 3 ON, 3 OFF).
2. On days where a daily response time has been entered and a normal display occurs such as 3 ON with an arrow appearing above **1-7**, press the button to finish the recall procedure.

Program Change

1. To change one or more previously programmed START or STOP times without clearing the entire memory press the **Prog** button and **d** button until the required weekday is shown. Press to store the selected day.
2. Change the 1 ON time by pressing the **h** button or the **m** button. Press the **Prog** button to advance to the next time setting. Clear the program by pressing **h** and **m** buttons simultaneously.
3. Press the **Prog** and **d** buttons to advance to the next program requiring a change.

4. When all changes are complete, press ⏲ . The timer is now set to function as programmed.

Vacation/Holiday Setting

The Vacation/Holiday Setting suspends the automatic program sequence from 1 to 45 days.

1. During the vacation/holiday setting procedure, press and hold the **h** button.
2. Press ☜ for the number of nonexercising days desired. After 45 days the display returns to zero. The vacation/holiday program starts at 12:00 a.m. the next day and is indicated on the display by ≡ OFF.

NOTE

The vacation/holiday setting places the exercise cycle (plant exerciser) on hold only. Should failure of the utility/normal power source occur, the transfer switch will start the generator set and transfer to the emergency/generator power source when voltage/frequency conditions are met. When utility/normal power is restored, the transfer switch will return to the utility/normal power position.

3. To recall/check the remaining vacation/holidays, press **h**. The display will momentarily show the number of days.
4. To change the number of vacation/holidays, press and hold **h** while pressing ☜ each time until the desired number of vacation/holidays is displayed.

Temporary Program Override

1. Press ☜ to alternate between the ON and OFF modes. To bypass the present programmed mode and place the plant exerciser in the ON or OFF mode (as displayed on the readout). **Changing the OFF mode will signal the generator set to start.** The plant exerciser will remain in this position until changed by the next programmed mode.
2. If override is no longer required, press ☜ to place plant exerciser in normal automatic mode.

Permanent Program Override

Press ☜ and **m** simultaneously to switch between modes ON ● and OFF ●. The automatic normal programmed mode bypasses the present programmed mode and places the plant exerciser in one of the other two modes. The plant exerciser will remain in the ON ● or OFF ● position until the permanent override is manually changed.

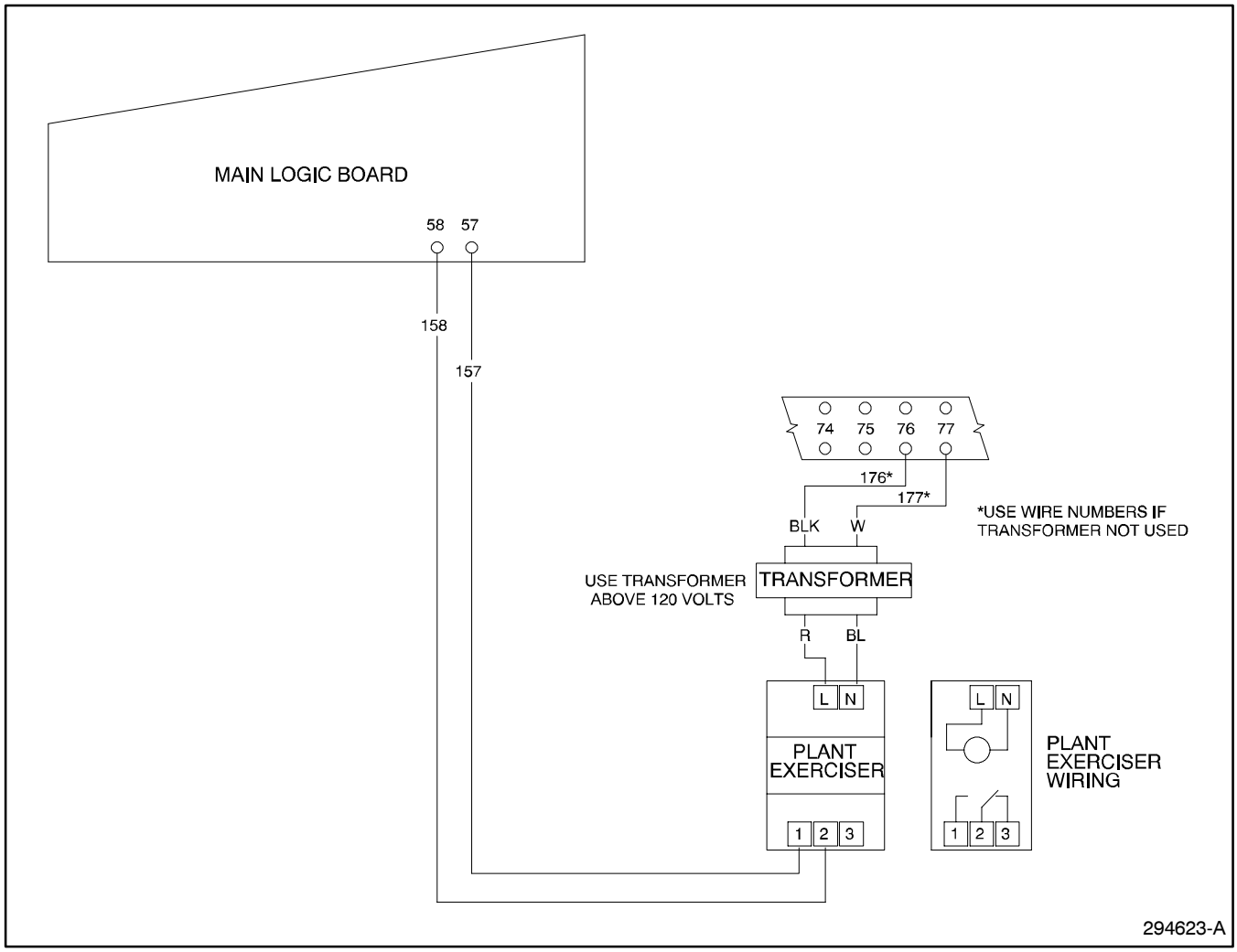


Figure 5-3. Timer Connection Schematic

Troubleshooting

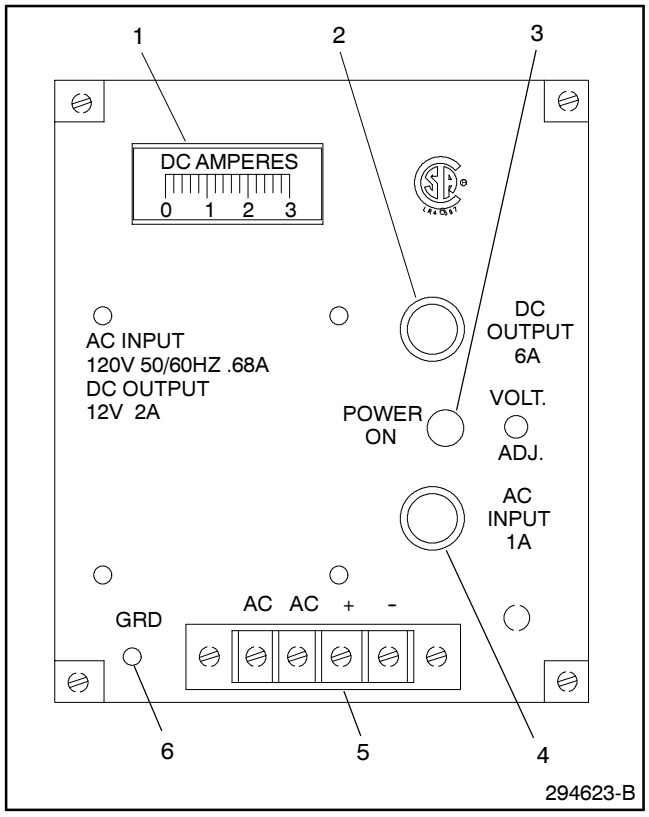
Plant Exerciser does not function correctly

Step	Test Procedure	Yes Action	No Action
A1	Is there rated line-to-line voltage between terminals 76 and 77 on terminal block TB-6?	Proceed to A2	Source voltage is not available. Refer to Section 4.
A2	Are there 120 vac between terminals L and N of the plant exerciser?	Proceed to A3	Proceed to A6
A3	Is the plant exerciser display on?	Proceed to A4	Replace the plant exerciser.
A4	Place a jumper between terminals 1 and 2 of the plant exerciser. Does the generator set start?	Proceed to A5	Proceed to A8
A5	Is the plant exerciser programmed correctly? Refer to page 5-2 for programming information.	Replace the plant exerciser.	Reprogram the plant exerciser.
A6	Is there a transformer wired between terminal block TB-6 and the plant exerciser?	Proceed to A7	Replace the leads from TB-6 to the plant exerciser.
A7	Is there rated line voltage on the primary windings of the transformer?	Replace the transformer assembly.	Replace the leads from TB-6 to the transformer.
A8	Place a jumper between terminals 58 and 57 of TB-1. Does the generator set start?	Replace leads 157 and 158 between TB-1 and the plant exerciser.	Proceed to A9
A9	Does the generator set start manually from the test switch?	Replace the logic board.	Refer to the engine service manual.

Accessory 24-XX-A,B Battery Charger

Specifications

The automatic battery charger is designed to maintain lead-acid automotive-type batteries in a fully charged state without any manual intervention. The charger output provided by the power transformer is controlled by the circuit board. The control board provides the charger with current-limiting, AC line compensation, reverse-polarity protection, ambient-temperature compensation, and a constant-voltage charging mode. The control circuit board continuously monitors the battery and load conditions to maintain the battery's state of charge. Refer to Figure 5-4 for component identification. The battery chargers are factory adjusted to maintain the battery at the proper float voltages. The 12-volt battery charger will maintain a lead-acid (6-cell) battery without adjustment. The 24-volt battery charger will maintain a lead-acid (12-cell) battery without adjustment.



1. DC Ammeter
2. DC Output Fuse
3. "Power On" Lamp
4. AC Input Fuse
5. Terminal Block
6. Ground Terminal

Figure 5-4. Battery Charger Components

Features

Current Limiting

The battery charger is protected from overload by its current-limiting circuitry. This circuitry continuously monitors the charger output current and is set to limit the current to 2 amps from full load to short circuit. Therefore, no crank disconnect is required when the plant is exercised.

Reverse Polarity Protection

When the battery charger is connected to the battery, the reverse polarity protection circuit determines if the positive lead from the battery charger is connected to the positive terminal on the battery, and the negative lead from the battery charger is connected to the negative terminal on the battery. If the polarity is incorrect, the charger will not turn on when AC input is connected.

Automatic Float Operation

When the battery charger is connected to the battery and AC power is applied to the charger, the charger operates in the constant-current mode until the battery voltage rises to the preset float level. At the preset float level, the charger will switch to the constant-voltage float mode. The charger will operate in constant-voltage float mode until AC input power is lost or the current required to maintain the battery at the float voltage setting exceeds 2 amps.

The battery charger will provide temperature compensation of -2 mV/°C per cell over the ambient temperature range from -40°C (-40°F) to +60°C (+140°F). This feature will automatically adjust the float voltage setting to prevent the battery from being overcharged at high ambient temperatures and undercharged at low ambient temperatures.

AC Input Fuse

When AC input is applied, the AC input fuse will open to protect the power transformer from damage caused by a short circuit. The fuse may also open if it is subjected to vibration. Replace the fuse to restore charger operation.

DC Output Fuse

The DC output fuse will open and protect the power transformer from damage if the current limit setting has been disabled or set to its maximum. It will also open if the charger output leads are shorted together.

Power On Lamp

The Power On lamp is connected across the power transformer's primary winding and indicates when AC power is present.

⚠ WARNING

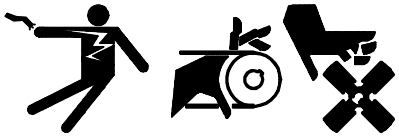
Hazardous voltage.
Can cause severe injury or death.

Do not open enclosure until all power sources are disconnected.

(under 600 Volt)

Hazardous voltage can cause severe injury or death. Deenergize both normal and emergency power sources before proceeding. Move generator set master switch on controller to OFF position and disconnect battery negative (–) before working on transfer switch! Turn the transfer switch selector switch to the OFF position.

⚠ WARNING



Accidental starting.
Can cause severe injury or death.

Disconnect battery cables before working on generator set (negative lead first and reconnect it last).

Accidental starting can cause severe injury or death. Turn generator set master switch to OFF position, disconnect power to battery charger, and remove battery cables (remove negative lead first and reconnect it last) to disable generator set before working on any equipment connected to generator set. The generator set can be started by automatic transfer switch or remote start/stop switch unless these precautions are followed.

⚠ WARNING

Explosion.
Can cause severe injury or death. Relays in battery charger cause arcs or sparks.

Locate in a well-ventilated area. Keep explosive fumes away.

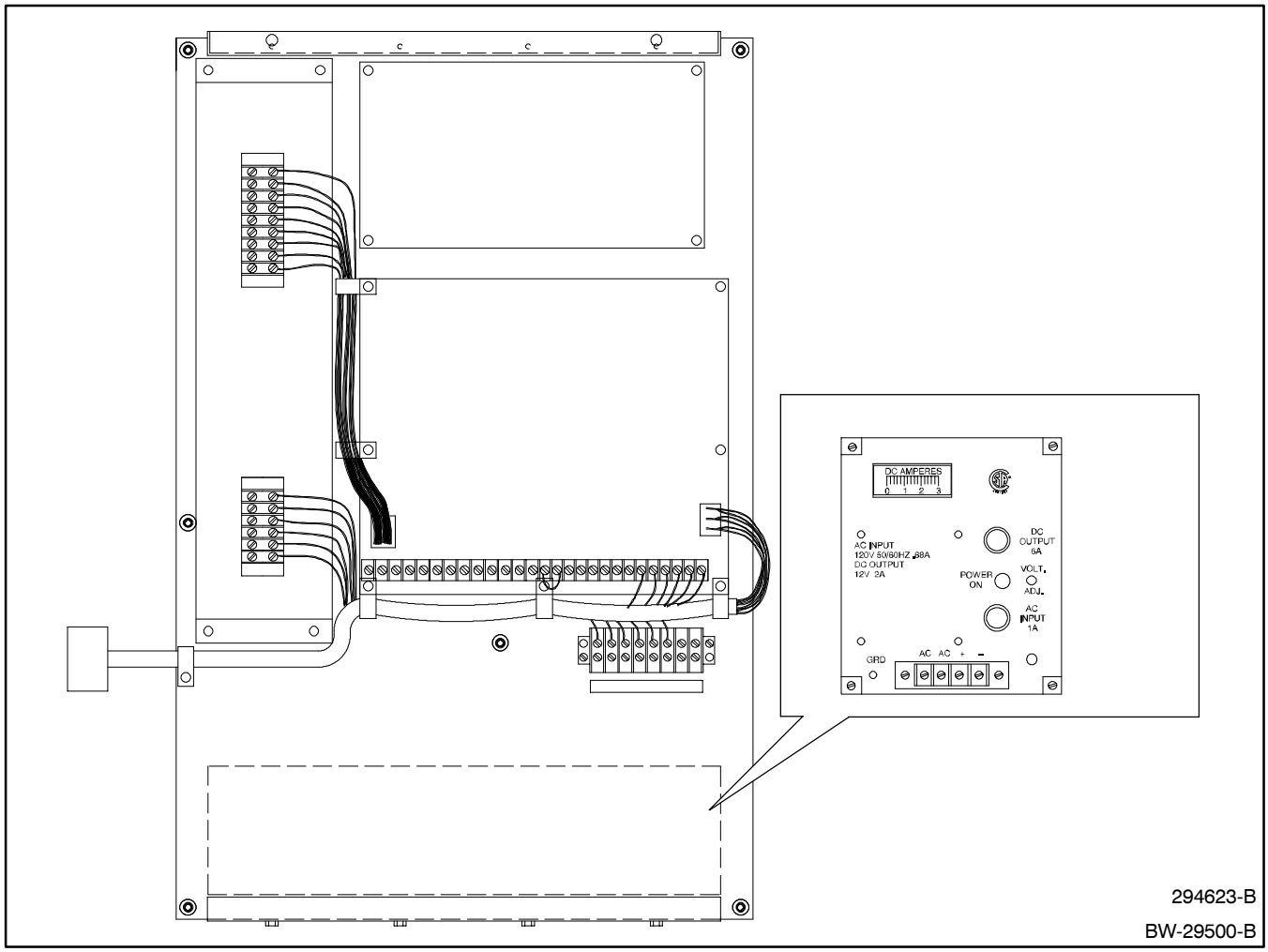


Figure 5-5. Battery Charger Location on Inner Panel—Solid-State Transfer Switch

To Disconnect Charger (When Replacing or Servicing Battery)

1. Move generator master switch to OFF position.
2. Remove AC power supply from battery charger.
3. Remove charger leads from battery, negative lead first.

Battery Charger Operation

Charging Lead-Acid Batteries

Charge 6- or 12-cell lead-acid batteries according to the following procedure.

1. Inspect battery for defective cables, loose posts, and loose terminals. Battery terminals and battery charger clips must be tight and cleaned of all corrosion for efficient charging.
2. Check the fluid level in each cell. If fluid level is low, add distilled water until fluid level is full. (No maintenance is required for maintenance-free batteries.) When using a dry-charge battery, give the battery a conditioning charge immediately after adding the electrolyte fluid. An automatic charger will not charge a dry-charge battery unless it has been given a conditioning charge. Follow the battery manufacturer's recommendations for length of charge.
3. The ammeter indicates the charge rate the charger is delivering to the battery. The charger control circuit limits the maximum charging current to 2 amps. No cranking disconnect is required because of the current-limit protection feature. A battery is almost fully charged when one of the following occurs:

- **Charging rate tapers to zero.** As a battery becomes charged, the battery voltage approaches the control voltage setting. The ammeter needle may fluctuate, indicating a continuous supply of pulsating current that automatically keeps the battery charged.
- **Specific gravity reading (using a hydrometer) is between 1.250 and 1.285 at an electrolyte temperature of 26.7°C (80°F).**
- **Bubbles appear at the surface of the battery fluid.** Bubbles indicate a battery is from 80 to 85% charged. Vigorous bubbling occurs when the battery is near full charge.

Charger Voltage Adjustment

The battery charger's output settings are factory set and normally require no customer adjustment. If adjustment is required, contact an authorized dealer/distributor for service or service literature. The factory settings are listed below.

Charger Voltage	Float Voltage	Current Limit (Amps)
12	13.2	2
24	26.4	2

Figure 5-6. Factory Output Settings

Charger and Battery Maintenance

1. Check battery terminals and charger connectors for clean contact surfaces. Clean battery terminals and charger connectors as necessary with a mild baking soda/water solution. If battery charger does not work, see Troubleshooting section below.
2. Check battery fluid level regularly; maintain battery fluid at the full level.

Troubleshooting

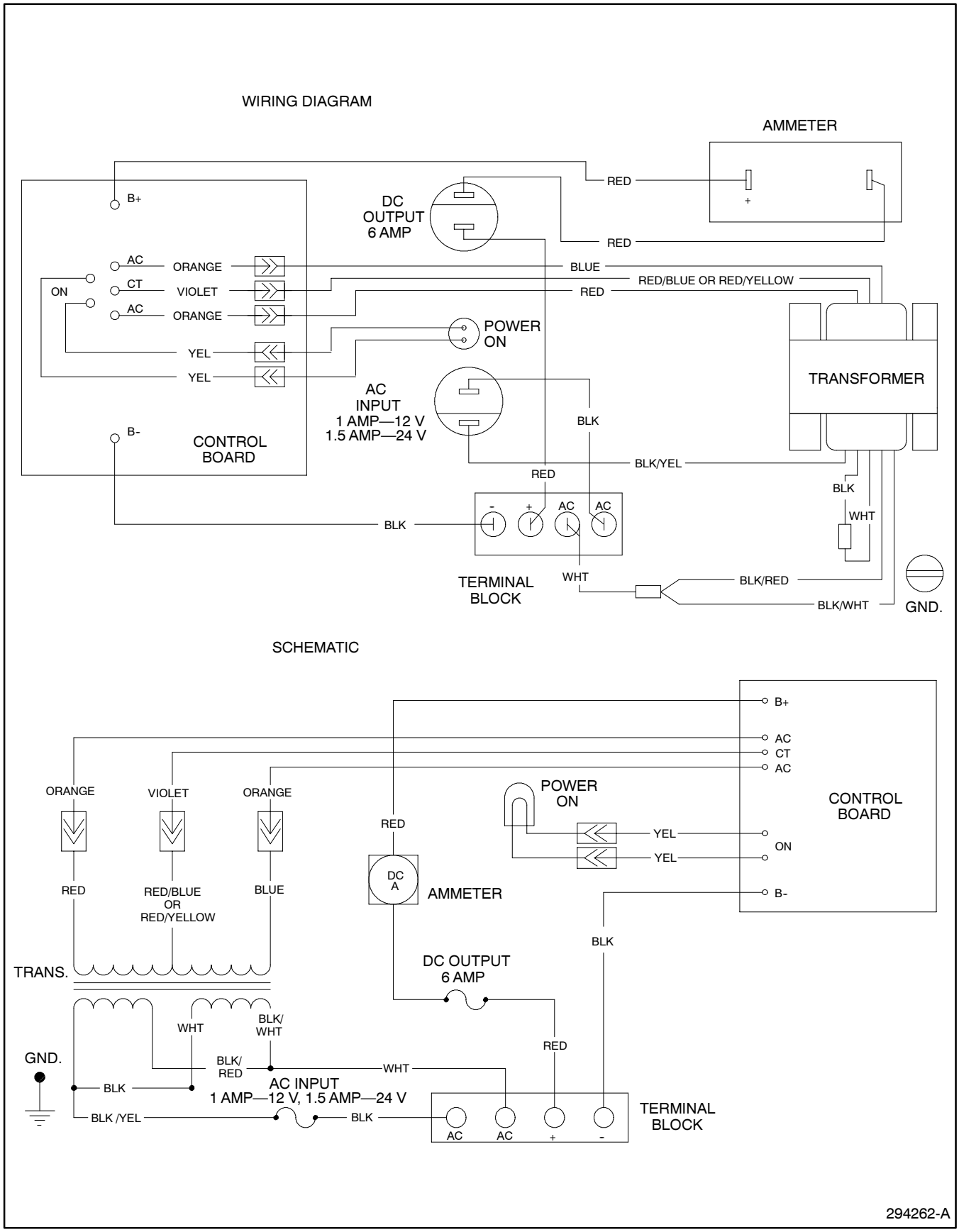
No Ammeter Reading on Battery Charger

Step	Test Procedure	Yes Action	No Action
A1	Check the battery charger connections to the battery for correct polarity: positive lead from battery charger to positive terminal on battery, negative lead from battery charger to negative terminal on battery. Is the polarity correct?	Proceed to A2	Reverse battery charger leads to battery.
A2	Turn off AC supply to the battery charger. Are the battery terminals clean and tight?	Proceed to A3	Clean and tighten the battery terminals.
A3	Is there line-to-line voltage at the AC input terminals of the battery charger?	Proceed to A5	Proceed to A4
A4	Is there line-to-line voltage at terminals 78 and 79 on terminal block TB-6?	Replace leads from terminal block TB-6 to battery charger.	Power is not available. Check wiring harness to contactor for an open.
A5	Check the AC input and DC output fuses. Are the fuses blown?	Replace fuse.	Replace battery charger.

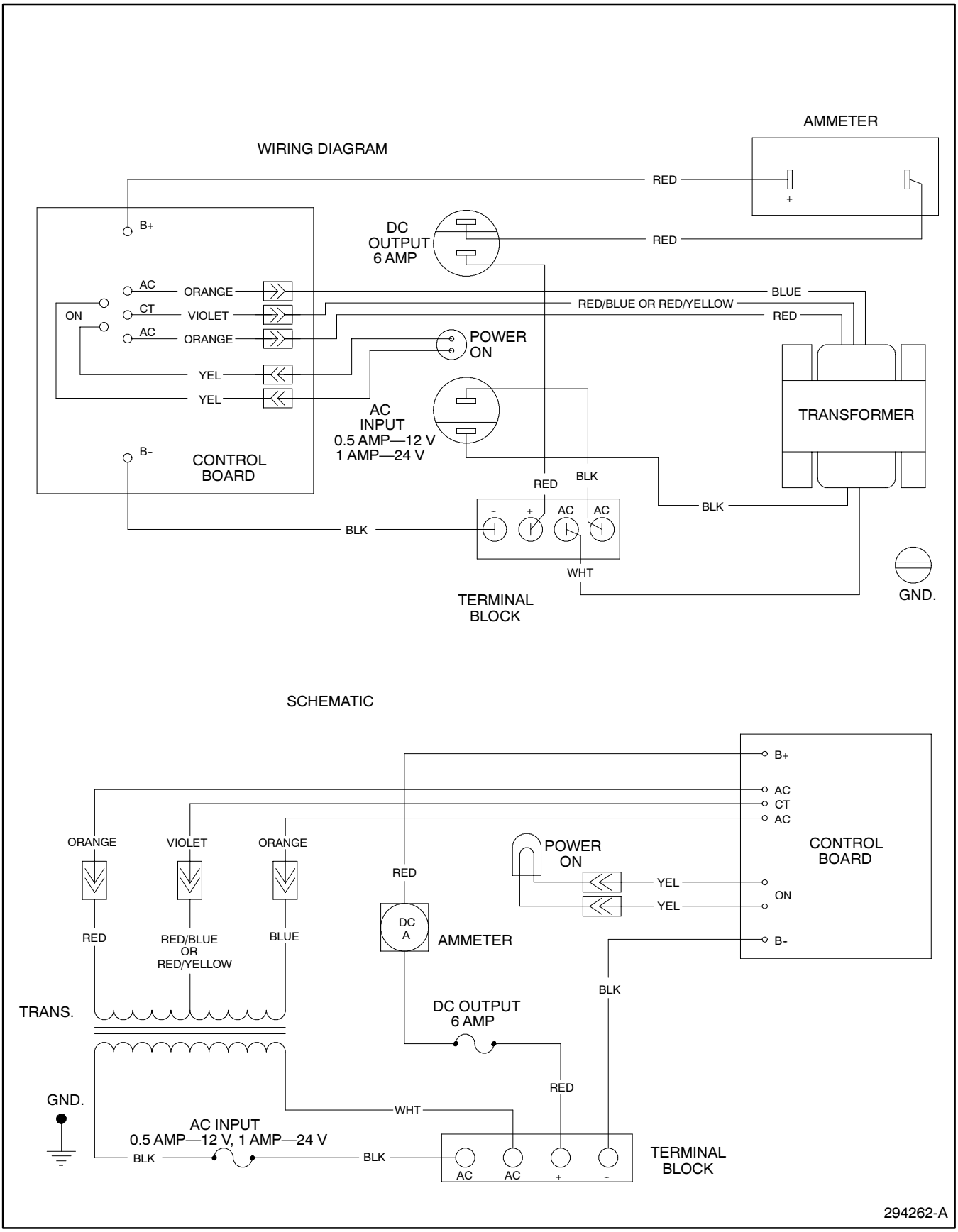
Ammeter Remains at 2 Amps Indefinitely

Step	Test Procedure	Yes Action	No Action
B1	Is the battery charger output voltage the same as the battery(s) voltage?	Proceed to B2	Replace battery charger to match battery voltage.
B2	Disconnect the battery charger from the batteries. Does the ammeter on the battery charger go to zero?	Proceed to B3	Replace battery charger.
B3	Do the batteries have any shorted cells?	Replace batteries.	Proceed to B4
B4	Are the batteries severely discharged?	Remove battery charger leads from batteries and connect a heavy-duty battery charger to charge the batteries.	Replace battery charger.

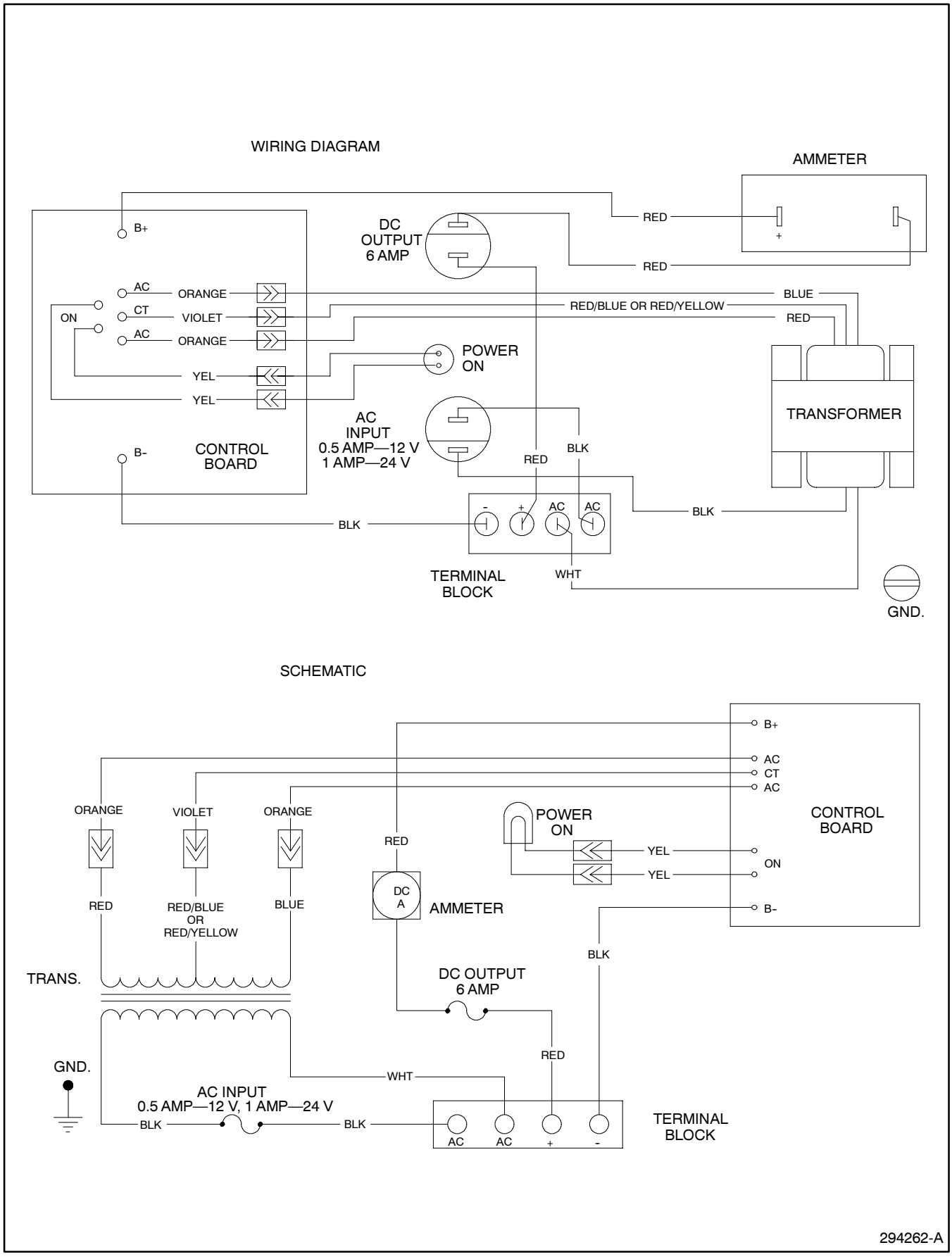
Battery Charger Wiring Diagrams



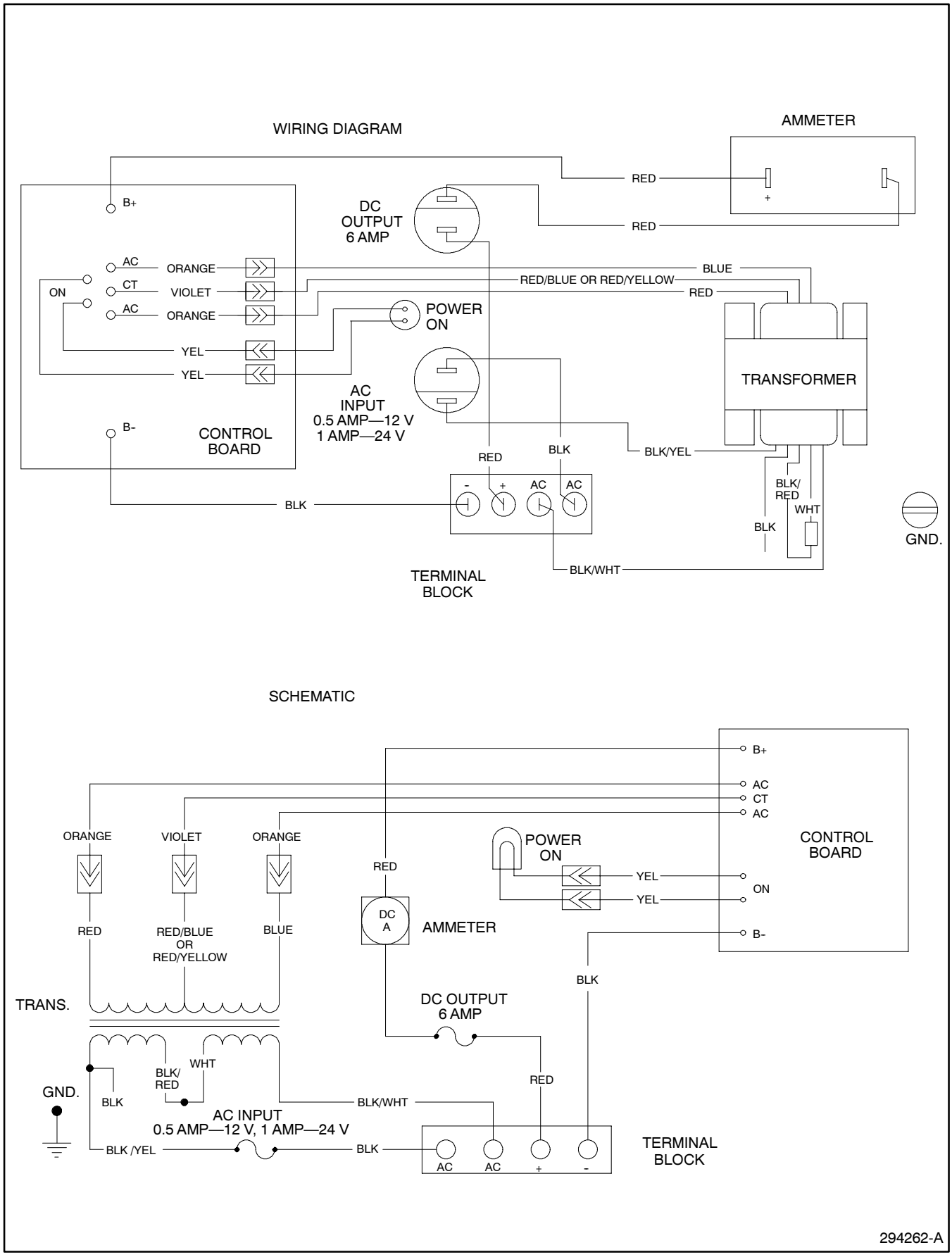
Wiring Diagram, Schematic—120-Volt Battery Charger



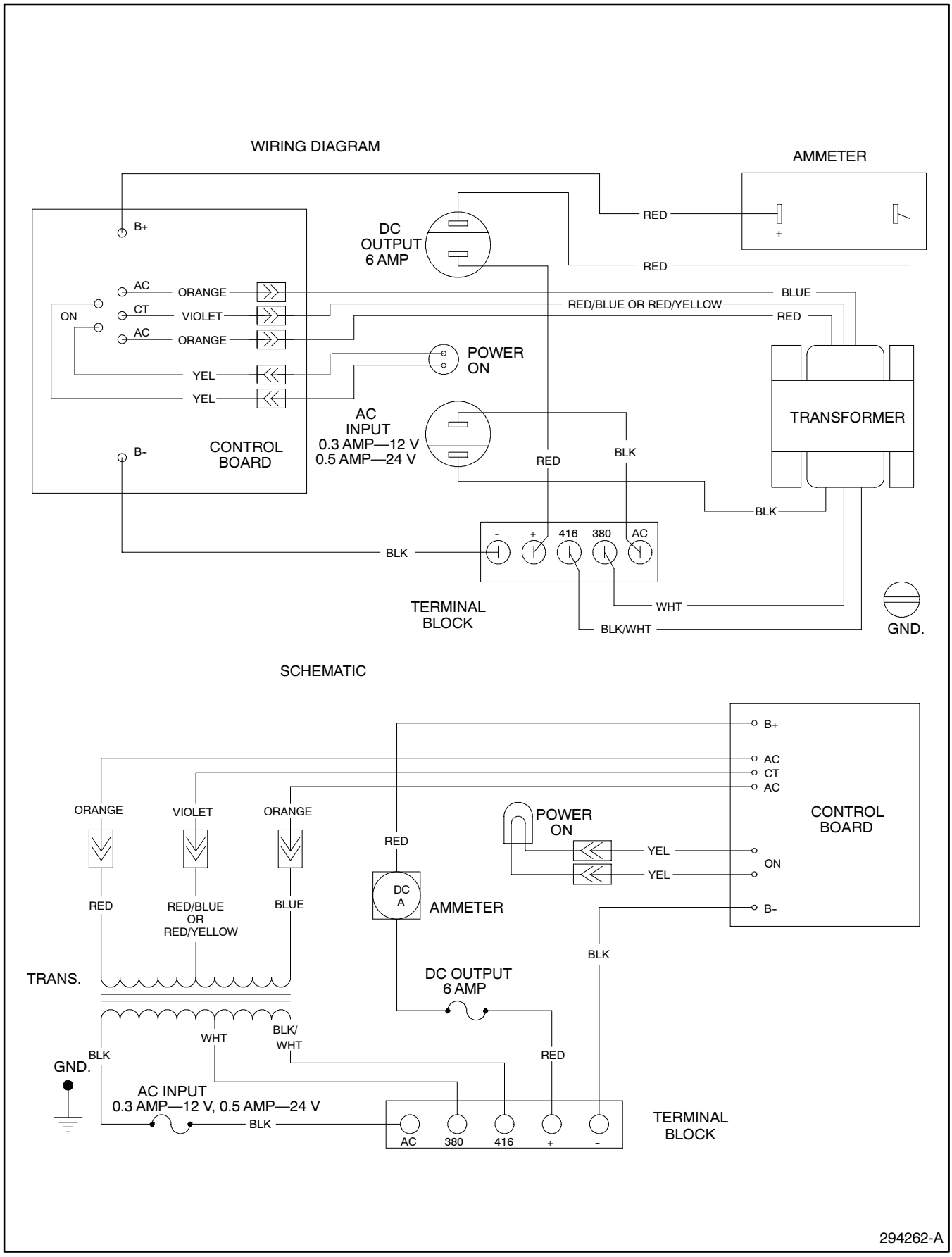
Wiring Diagram, Schematic—208-Volt Battery Charger



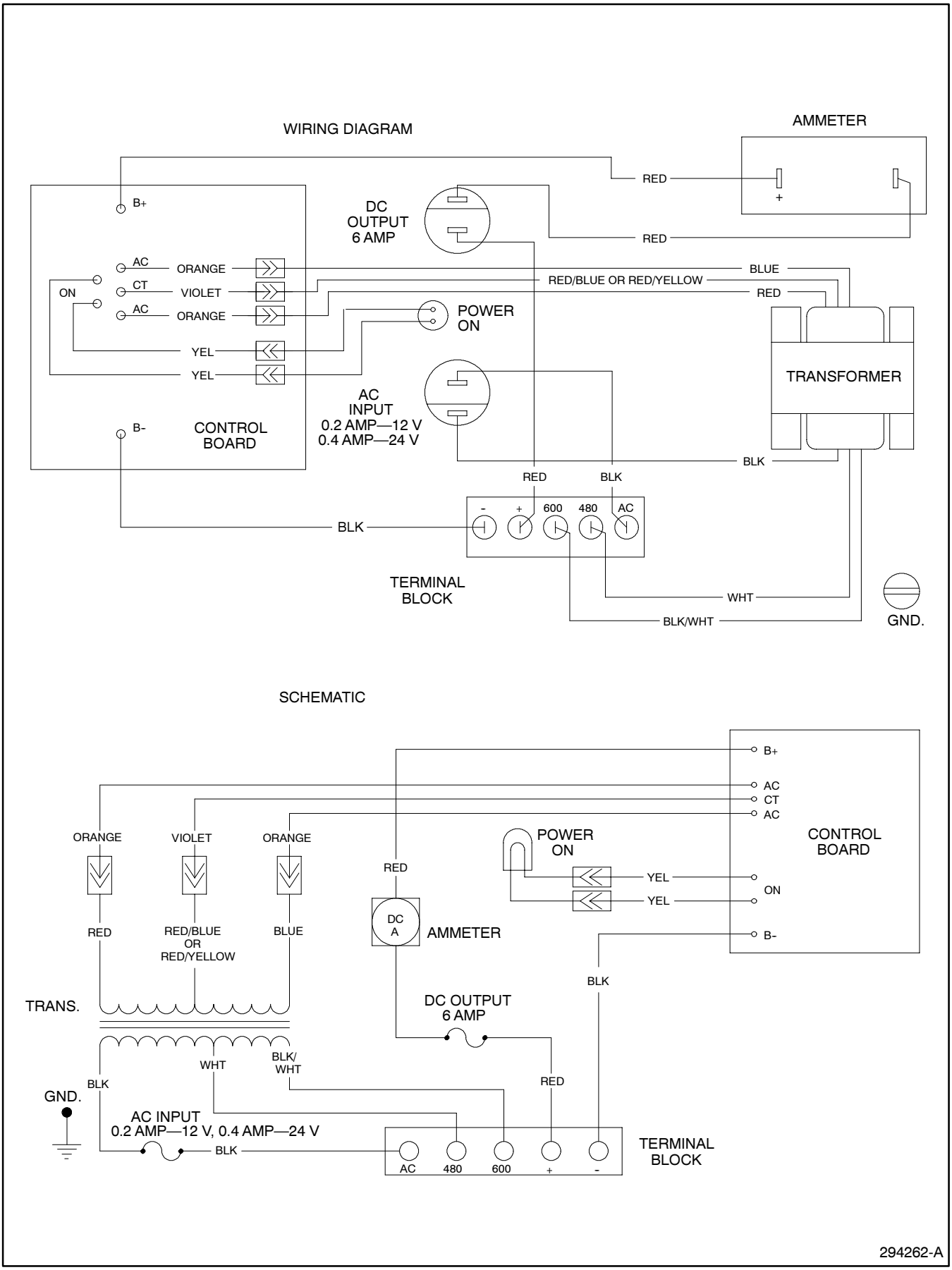
Wiring Diagram, Schematic—220-Volt Battery Charger



Wiring Diagram, Schematic—240-Volt Battery Charger



Wiring Diagram, Schematic—380/416-Volt Battery Charger



Wiring Diagram, Schematic—480/600-Volt Battery Charger

Accessory DA-26

Accessory DA-26 senses normal source three phase voltage directly from the power conversion unit.

A harness connects the optional circuit board to the P3 connector on the main logic board. See Figure 5-7 for wiring connections. Adjustment pots for NAB and NBC sensing circuits and jumper on the main logic board have been factory set. Use the following table to assist problem diagnosis with this accessory.

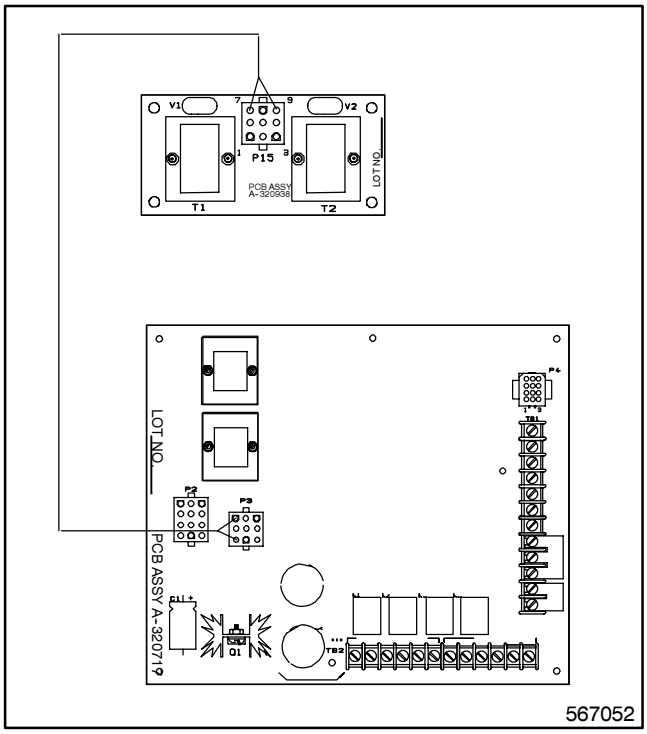


Figure 5-7. Accessory DA-26 Connection

Troubleshooting

Logic does not sense three phase voltage on the normal source.

Step	Test Procedure	Yes Action	No Action
A1	Is the normal source present on all three phases?	Proceed to step A2	The normal source is not available on all three phases of the normal source. Check the normal source for rated voltage.
A2	Is ribbon cable connected between plug P15 on the sensing board and plug P3 on the logic board?	Proceed to step A3	Plug ribbon cable from plug P15 on the logic board to P3 on the sensing board.
A3	Check for source voltage at the sensing board. Refer to Figure 5-8 for the correct voltage and pin numbers. Is the voltage correct?	Proceed to step A4	Proceed to step A6
A4	Check for the correct transformer voltage at the logic board. Refer to Figure 5-9 for the correct voltage and pin numbers. Is the voltage correct?	Proceed to step A6	Proceed to step A5
A5	Remove the harness from the main logic board. Perform a continuity test on the cable. Refer to Figure 5-10 for cable connections. Does the cable have an open or a short circuit?	Replace the sensing board.	Replace the interconnection cable.
A6	Remove the harness from the main logic board. Perform a continuity test on the cable. Refer to Figure 5-10 for cable connections. Does the cable have an open or a short circit?	Replace the logic board.	Replace the interconnection cable.

Pin Number	Voltage
1 to 2	NA to NB
1 to 3	NA to NC
2 to 3	NB to NC

Figure 5-8. Normal Source Voltage

Pin Number	Voltage
4 to 7	1/25 of NA to NB
8 to 9	1/25 of NB to NC

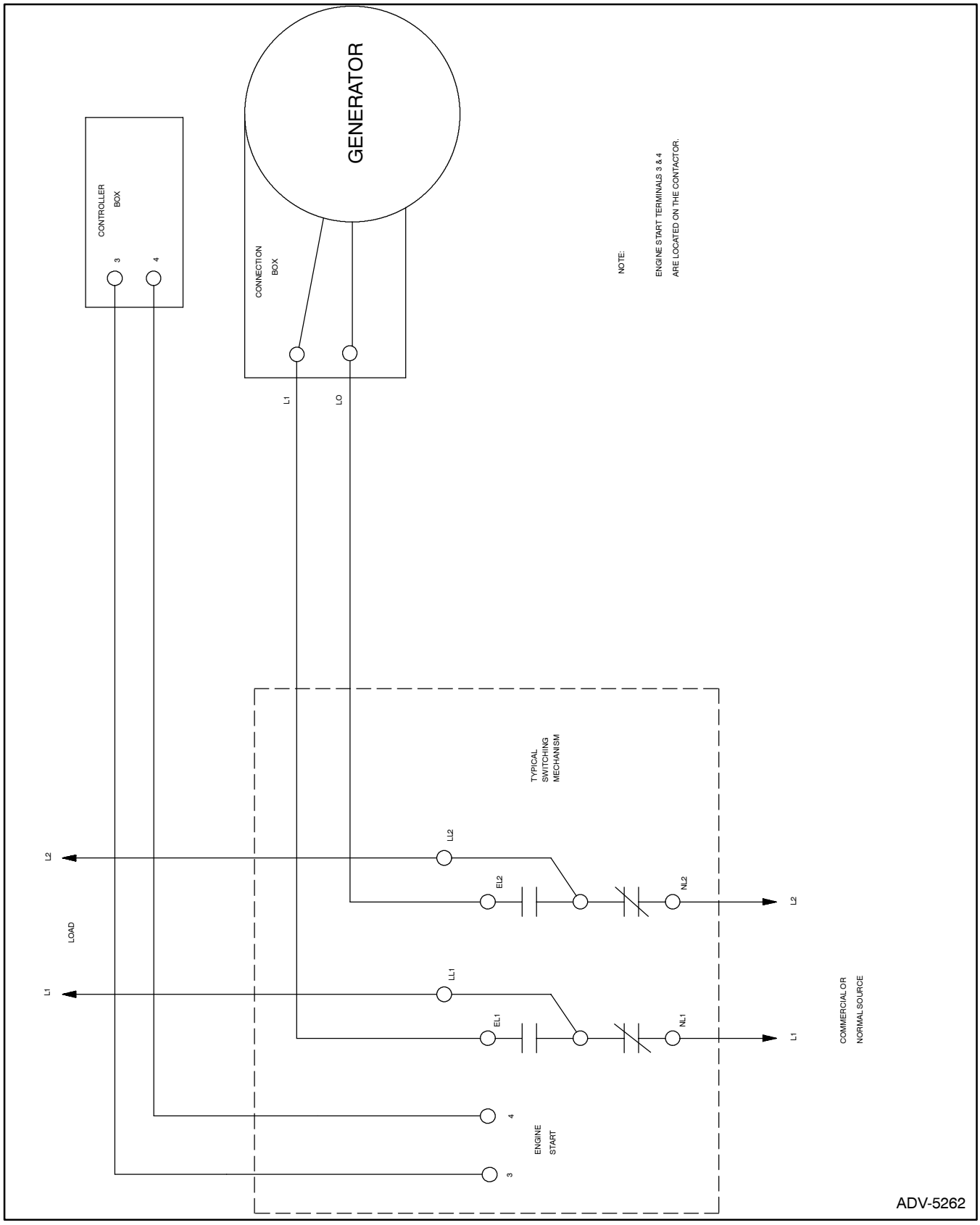
Figure 5-9. Transformer Voltage

Between pins		Continuity
P-3	P-15	
1	1	Yes
2	2	Yes
3	3	Yes
4	4	Yes
5	5	No
6	6	No
7	7	Yes
8	8	Yes
9	9	Yes

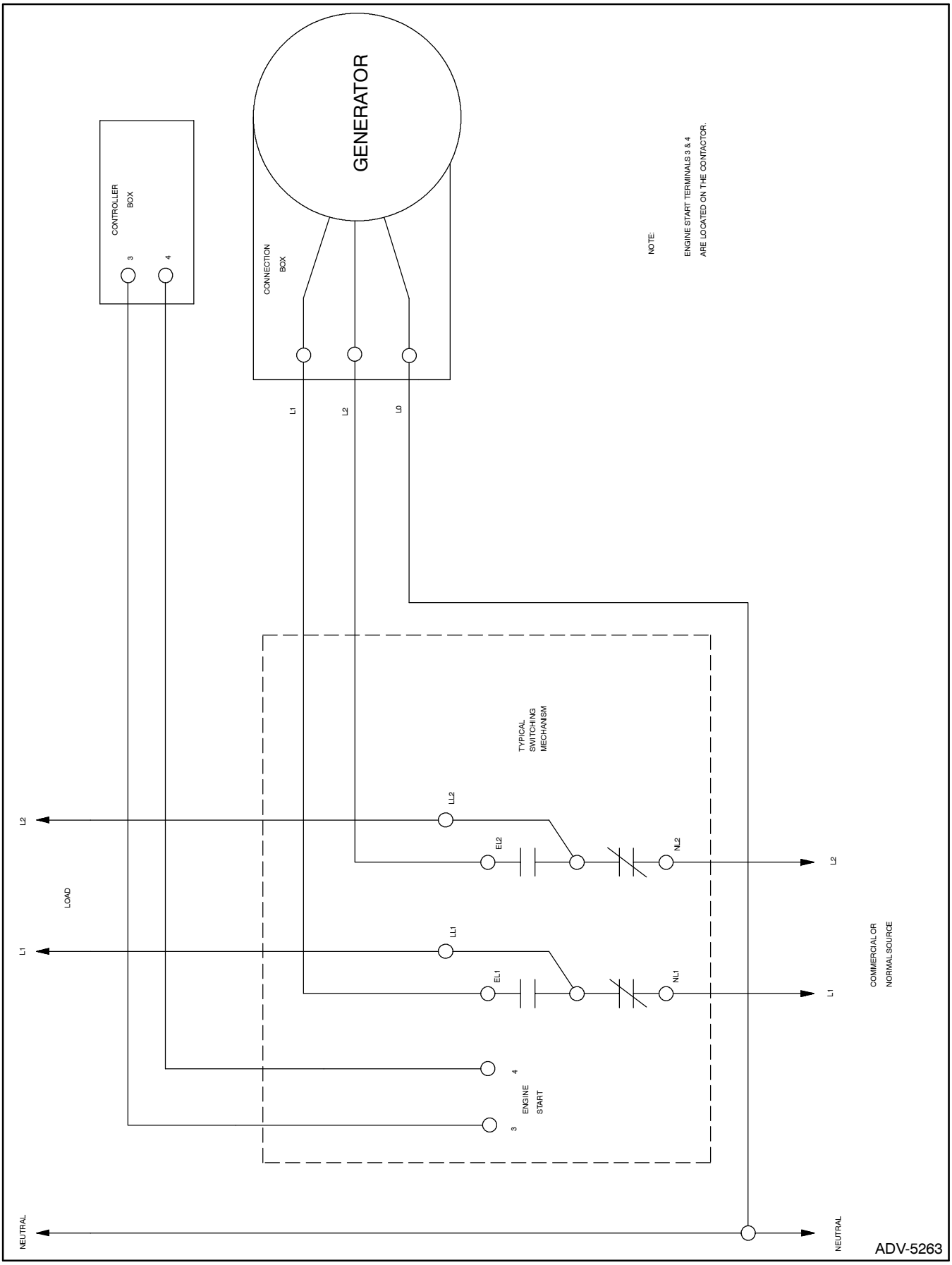
Figure 5-10. Ribbon Cable Connections

Notes

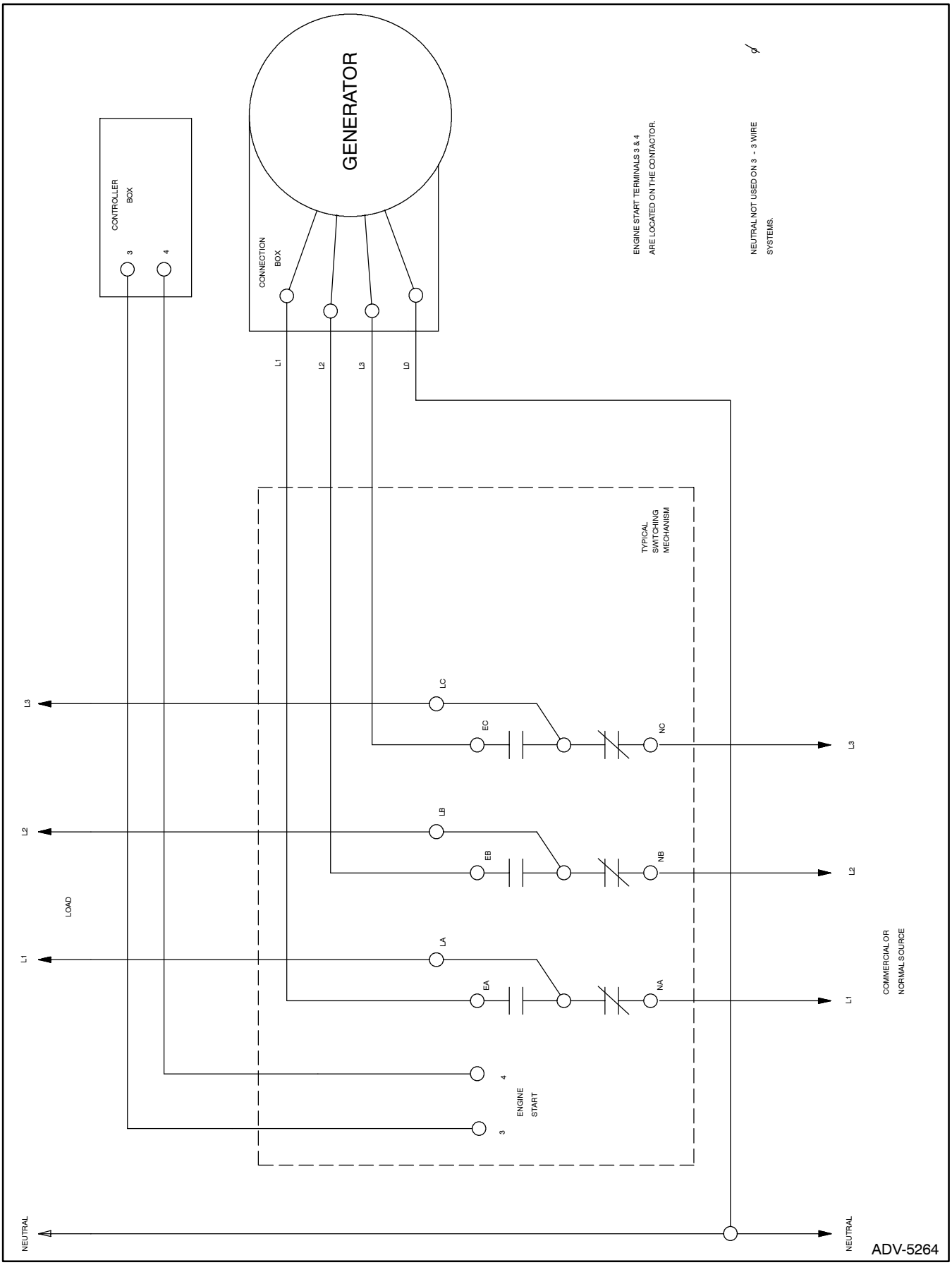
Section 6. Wiring Diagrams



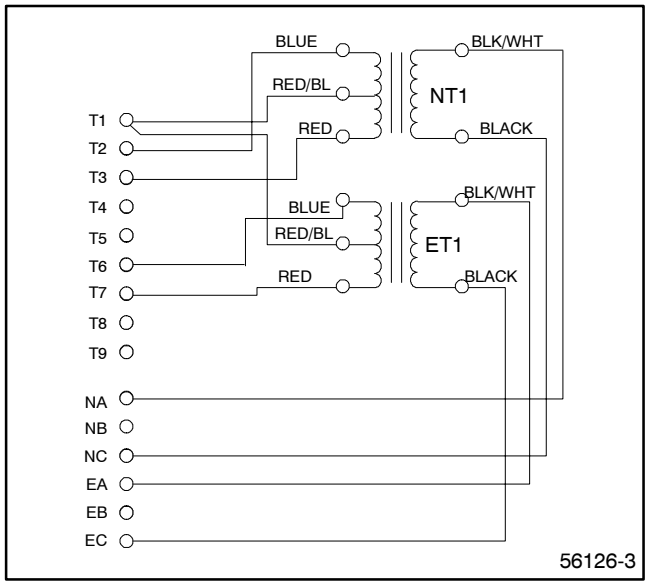
Generator/ATS Interconnect 1-Phase, 2 Wire



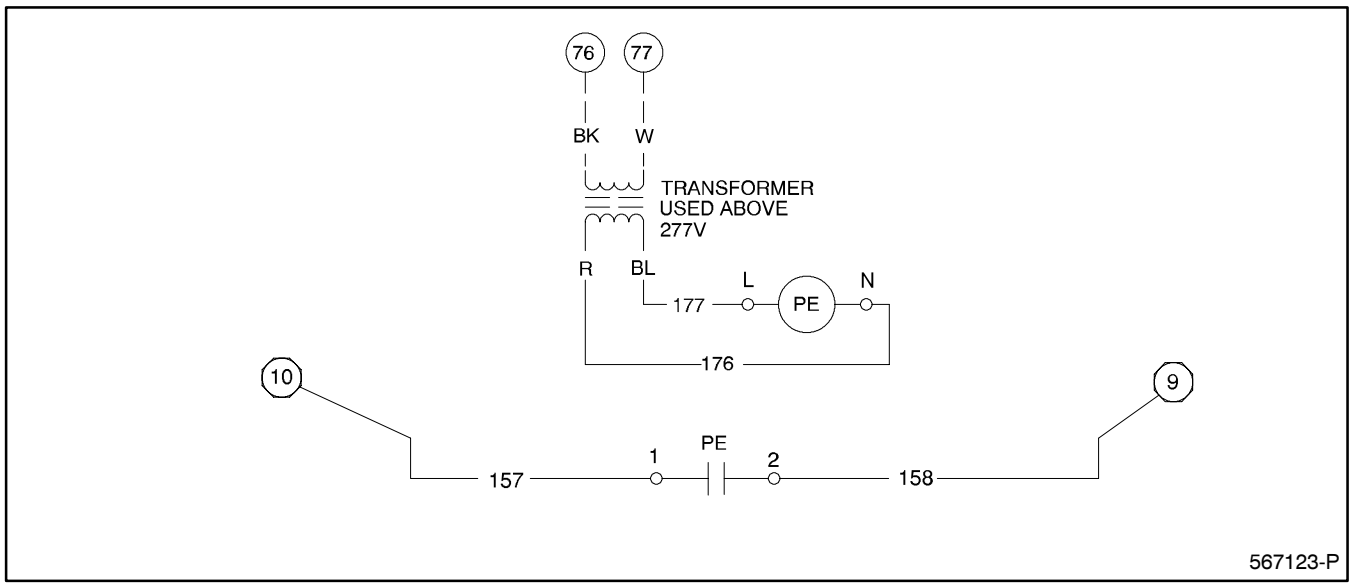
Generator/ATS Interconnect, 1-Phase, 3 Wire



Generator/ATS Interconnect, 3-Phase, 3 or 4 Wire



1-Phase ATS Transformer

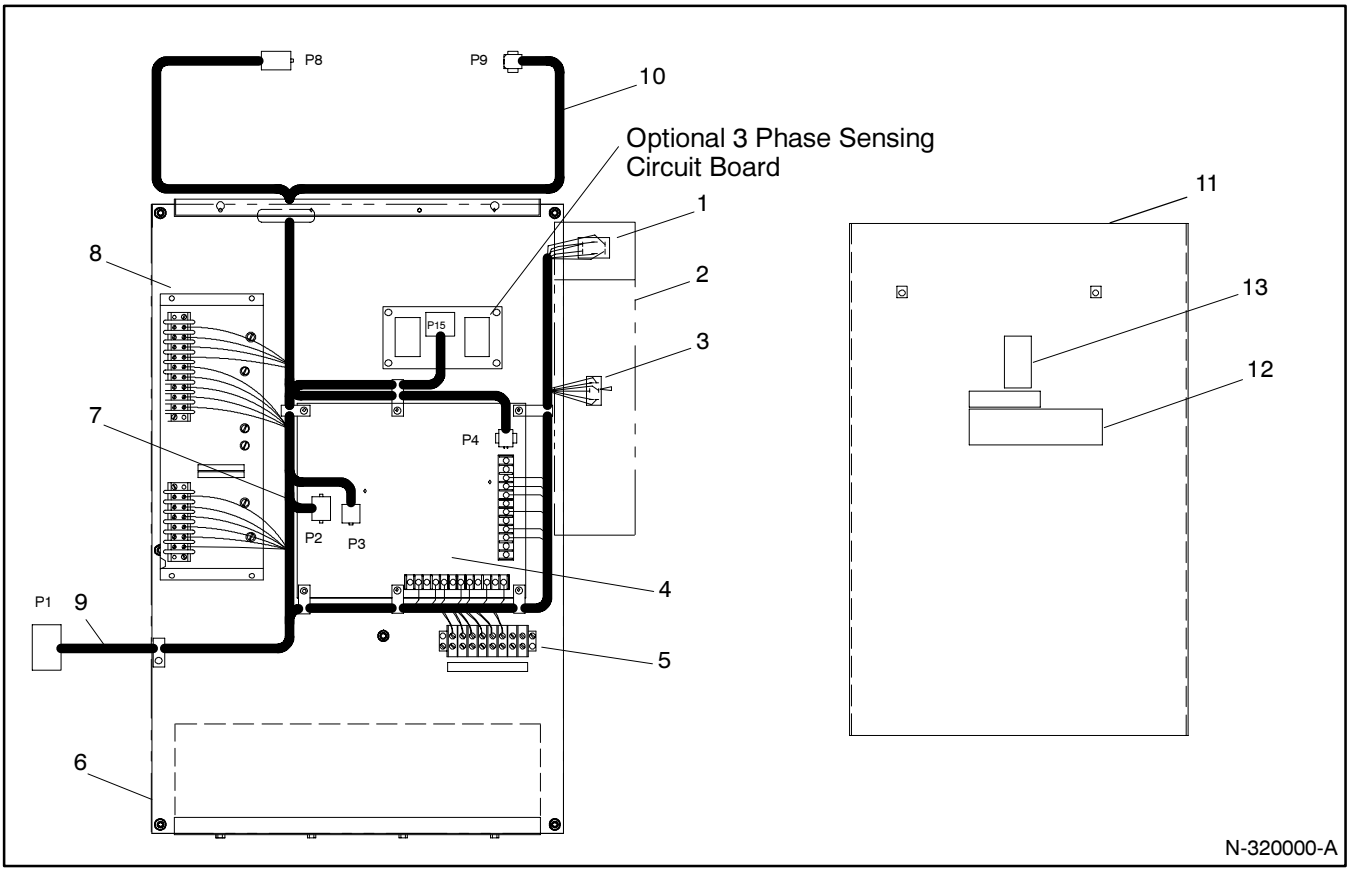


Accessory DA-23-P

Notes

Section 7. Service Parts

Inner Panel



Item	Qty.	Description	Part No.
1	1	Light, rectangular	320827
2	1	Decal (outside of door)	321159
3	1	Switch, Toggle (momentary)	295068
	1	Switch, Toggle (maintained)	268015
4	1	Circuit Board Assembly	A-320717
5	1	Block, Terminal	295266
6	1	Panel, inner	295005
7	1	Wiring Harness (Transformer)	321157
8	1	Transformer Assembly	Figure 7-1
9	1	Harness, logic/interface to power conversion unit	Figure 7-2
10	1	Harness, logic to interface	Figure 7-2

Item	Qty.	Description	Part No.
11	1	Guard	321017
12	1	Decal	295261
13	1	Decal	294328

Voltage	Phase	Item 8 Transformer Assembly
120	1	A-320997
208	1	A-320998
240	1	A-320996
380	1	A-321019
416	1	A-321020
480	3	A-320999
600	3	A-321001

Figure 7-1. Transformer Part Numbers

Switch	Item 10 Logic to Interface	Item 9 Interface to Power Conversion Unit
TES, TLS		
25-180 amp standard and programmed transition	320959	321120
25-180 amp standard and programmed transition	320961	321281
MNS, MMS		
40-160 amp standard and programmed transition	320959	321175
250-1200 amp standard and programmed transition	320961	321163
1600-4000 amp standard and programmed transition	320961	321163
ZCS		
150-225 amp standard and programmed transition	320961	321081
260-1200 amp standard and programmed transition	320961	321081
800-1200 (4-pole) amp standard	320961	321080
800-1200 (4-pole) amp programmed transition	320961	321081
1600-4000 amp standard and programmed transition	320961	321081

Figure 7-2. Wiring Harness Part Numbers

Accessories

NOTE

Refer to the nameplate for a list of installed accessories.

Plant Exercisers

Accessory	Description	Part Number
23-PA	Clock, Time	294541
23-PB	Clock, Time Transformer	294541 295354
23-TC	Clock, Time Transformer	294541 295355
23-PD	Clock, Time Transformer	294541 295301
23-PE	Clock, Time Transformer	294541 295302
23-PF	Clock, Time Transformer	294541 295299

Battery Chargers

Accessory	Description	Part Number
24-60A	Charger Assembly, Battery Fuse, 6.0 amp Fuse, 0.2 amp	A-294236 226520 226527
24-60B	Charger Assembly, Battery Fuse, 6.0 amp Fuse, 0.4 amp	A-294237 226520 226528
24-62A	Charger Assembly, Battery Fuse, 6.0 amp Fuse, 1.0 amp	A-294226 226520 226525
24-62B	Charger Assembly, Battery Fuse, 6.0 amp Fuse, 1.5 amp	A-294227 226520 291207
24-63A	Charger Assembly, Battery Fuse, 6.0 amp Fuse, 0.5 amp	A-294230 226520 226521
24-63B	Charger Assembly, Battery Fuse, 6.0 amp Fuse, 1.0 amp	A-294231 226520 226525
24-64A	Charger Assembly, Battery Fuse, 6.0 amp Fuse, 0.5 amp	A-294232 226520 226521
24-64B	Charger Assembly, Battery Fuse, 6.0 amp Fuse, 1.0 amp	A-294233 226520 226525
24-66A	Charger Assembly, Battery Fuse, 6.0 amp Fuse, 0.2 amp	A-294236 226520 226527
24-66B	Charger Assembly, Battery Fuse, 6.0 amp Fuse, 0.4 amp	A-294237 226520 226528
24-68A	Charger Assembly, Battery Fuse, 1.0 Fuse, 5 amp	A-294229 226525 239298
24-68B	Charger Assembly, Battery Fuse, 1.0 Fuse, 5 amp	A-294229 226525 239298
24-71A	Charger Assembly, Battery Fuse, 6.0 amp Fuse, 0.3 amp	A-294234 226520 226526
24-71B	Charger Assembly, Battery Fuse, 6.0 amp Fuse, 0.5 amp	A-294235 226520 294552
24-73A	Charger Assembly, Battery Fuse, 6.0 amp Fuse, 0.3 amp	A-294234 226520 226526
24-73B	Charger Assembly, Battery Fuse, 6.0 amp Fuse, 0.5 amp	A-294235 226520 294552

Three-Phase Sensing

Accessory	Description	Part Number
DA-26	PCB Assembly Harness, Wiring	A-320938 321111

Notes

Appendix A. Glossary of Abbreviations

Abbreviations are used throughout this manual. Normally they will appear in the text in complete form with the abbreviation following in parentheses the first time they are used. After that they will appear in the abbreviated form. The commonly used abbreviations are shown below. Some items may not apply to this application.

Abbreviation	Description
ABDC	after bottom dead center
AC	alternating current
AISI	American Iron and Steel Institute
AHWT	anticipatory high water temp.
ALOP	anticipatory low oil pressure
AM	amplitude modulation
amp	ampere
amps	amperes
ANSI	American National Standard Institute
API	American Petroleum Institute
approx.	approximate, approximately
A/R	as required, as requested
A/S	as supplied, as stated, as suggested
ASA	American Standards Association (former name of ANSI)
ASME	American Society of Mechanical Engineers
assy.	assembly
ASTM	American Society for Testing Materials
ATDC	after dead top center
aux.	auxiliary
A/V	audio-visual
AWG	American Wire Gage
AWM	appliance wiring material
BBDC	before bottom dead center
BDC	before dead center
BHP	brake horsepower
bmep	brake mean effective power
BTDC	before top dead center
Btu	British thermal unit
°C	Celsius degree
cc	cubic centimeter
CCA	cold cranking amps
CEC	Canadian Electrical Code
cfh	cubic feet per hour
cfm	cubic feet per minute
CID	cubic inch displacement
cm	centimeter, centimeters
cmm	cubic meters per minute
co.	company
cont'd.	continued
CPVC	chloropoly vinyl chloride
CRT	cathode ray tube
CSA	Canadian Standards Association
CT	current transformer
cu. in.	cubic inch (es)
CWC	city-water cooled
cyl.	cylinder
dB	decibel
dBA	decibels (A weighted)
DC	direct current
DCR	direct current resistance
deg.	degree
dept.	department
dia.	diameter
DIN	Deutsches Institut fur Normung e. V. (also Deutsche Industrie Normenausschuss)
e.g.	example given
EIA	Electronic Industries Association
EMI	electromagnetic interference
EPA	Environmental Protection Agency
etc.	etcetera, (and so forth)
ext.	external
°F	Fahrenheit degree
fl. oz.	fluid ounce(s)
FM	frequency modulation
ft.	foot, feet
ft. lbs.	foot pound(s)
fs	full scale
ga.	gauge (meters wire size)
gal./gals.	gallon, gallons
gph	gallons per hour
gpm	gallons per minute
gr.	grade
grd.	ground
HCHT	high cylinder head temperature
HET	high exhaust temperature
Hg.	mercury (element)
H_2O	water
HP	horsepower
hr, hrs	hour, hours
HWT	high water temperature
Hz	hertz (cycles per second)
ID	inside diameter
IEEE	Institute of Electrical and Electronic Engineers
in.	inch, inches
inc.	incorporated
in. lbs.	inch pounds
int.	internal
int.-ext.	internal-external

Abbreviation	Description
ISO	International Standards Organization
J	joule, joules
JIS	Japanese Industry Standard
kg	kilogram, kilograms
kg/cm^2	kilograms per square centimeter
kgm	kilogram meter(s)
kJ	kilojoules (btu cal)
km	kilometer, kilometers
kPa	kiloPascal, kiloPascals
kph	kilometers per hour
kV	kilovolt
kVA	kilovolt amperes
kW	kilowatt, kilowatts
kWH	kilowatt hour
L	liter, liters
LxWxH	length x width x height
LED(s)	light emitting diode(s)
lb., lbs.	pound, pounds
L/hr.	liter per hour, liters per hour
L/min.	liter(s) per minute
LOP	low oil pressure
LP	liquified petroleum
LWT	low water temperature
m	meter, meters
m^3	cubic meter, cubic meters
max.	maximum
MCM	one thousand circular mils.
meggar	megohmmeter
MHz	megahertz
mi.	mile, miles
mil	one one-thousandth of an inch
min.	minimum
misc.	miscellaneous
mJ	milli joule(s)
MJ	mega joule(s)
mm	millimeter
m^3/min	cubic meters per minute
MPa	megaPascal
mpg	miles per gallon
mph	miles per hour
MS	military standard
mW	milliwatt(s)
MW	megawatt(s)
N/A	not available
NBS	National Bureau of Standards
N.C.	normally closed
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
Nm	Newton meter(s)
N.O.	normally open
no., nos.	number, numbers

Abbreviation	Description
NPT	National Standard taper pipe thread per general use
N/R	not required
OC	overcrank
OD	outside diameter
OEM	original equipment manufacturer
OS	overspeed
O/S	oversize
OSHA	Occupational Safety and Health Act
OV	overvoltage
oz.	ounce, ounces
PF	power factor
PMG	permanent magnet generator
pot	potentiometer
ppm	parts per million
psi	pounds per square inch
pt., pts.	pint, pints
PVC	polyvinyl chloride
qt., qts.	quart, quarts
qty.	quantity
ref.	reference
RFI	radio frequency interference
r.h.m.	round-head machine (screw)
rms	root means square
RPM	revolutions per minute
RTV	room temperature vulcanization
RV	recreational vehicle
SAE	Society of Automotive Engineers
SCR	silicon controlled rectifier
sec.	second, seconds
spec, specs	specification
sq.	square
sq. cm.	square centimeters
sq. in.	square inch(es)
tach	tachometer
TDC	top dead center
tech. pub.	technical publications
temp.	temperature
TIF	telephone influence factor
TP, TPs	technical publications
turbo	turbocharger
UHF	ultrahigh frequency
UNC	Unified coarse thread (was NC)
UNF	Unified fine thread (was NF)
UL	Underwriter's Laboratories, Inc.
U/S	undersize
U.S.A.	United States of America
V	volt, volts
vac	volts alternating current
vdc	volts direct current
VHF	very high frequency
W	watt, watts

KOHLER®
POWER SYSTEMS

KOHLER CO. Kohler, Wisconsin 53044
Phone 920-565-3381, Web site www.kohlergenerators.com
Fax 920-459-1646 (U.S.A. Sales), Fax 920-459-1614 (International)
For the nearest sales and service outlet in U.S.A. and Canada
Phone 1-800-544-2444

Kohler® Power Systems
Asia Pacific Headquarters
7 Jurong Pier Road
Singapore 619159
Phone (65)264-6422, Fax (65)264-6455

TP-5670 9/94b